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MINNESOTA RIVER BASIN REPORT

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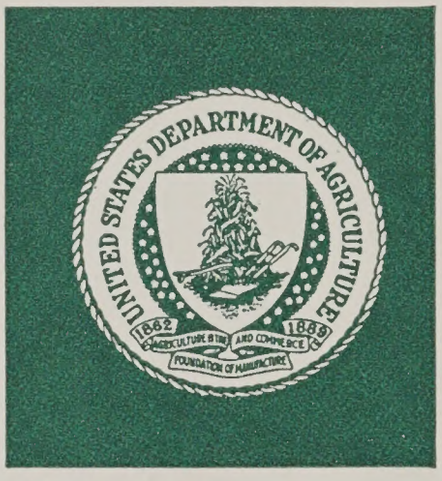

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MINNESOTA RIVER BASIN REPORT

prepared by:

THE SOUTHERN MINNESOTA RIVER BASIN COMMISSION

with assistance from:

The United States Department of Agriculture

Soil Conservation Service

Economic Research Service

Forest Service

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CHAPTER 114A

Southern Minnesota Rivers Basin Commission

114A.01 Legislative Findings; Policy. Subdivision 1. Because of recurring flood damage, and because of other problems such as pollution, deficiencies in recreational and conservational opportunities, planning and projects, and deficiencies in planning and coordinating for economic growth, a southern Minnesota rivers basin commission is hereby created and charged with the obligation to guide the creation and implementation of a comprehensive environmental conservation and development plan for the southern Minnesota rivers basin. The commission may utilize all available scientific, economic, legal, and social resources so as to make effective the purposes and policy of sections 114A.01 to 114A.09.

Subd. 2. For the purposes of sections 114A.01 to 114A.09, the southern Minnesota rivers basin is defined to include the area within the watersheds of rivers and streams tributary to the Minnesota river, and the areas within the watersheds of rivers tributary to the Mississippi river on the westerly side of the Mississippi south of its confluence with the Minnesota river. The planning for development of the southern Minnesota rivers basin will have considerable impact within the boundaries of Minneapolis and St. Paul.

114A.02 Definitions. Subdivision 1. For the purposes of sections 114A.01 to 114A.09, the terms defined in this section have the meanings ascribed to them.

Subd. 2. "Person" includes any firm, partnership, association, or corporation, and any public or political subdivision of the federal or state governments.

Subd. 3. "Commission" means the governing body of the southern Minnesota rivers basin commission.

Subd. 4. "Local governmental unit" means a county, town, city, or a political division or subdivision of the state.

Subd. 5. "Public health" includes any act or thing tending to improve the general sanitary conditions of the basin.

Subd. 6. "Public welfare", "general welfare", and "public benefit" include any act or thing tending to improve or benefit or contribute to the enhancement of the environment, the safety or well being of the general public or benefit the inhabitants of the basin.

Subd. 7. "Basin" means the area within the watersheds of rivers and streams tributary to the Minnesota river, and the areas within the watersheds of rivers tributary to the Mississippi river on the westerly side of the Mississippi south of its confluence with the Minnesota river.

Subd. 8. "County auditor" means the county auditor of any county located in whole or in part within the boundaries of the basin.

Subd. 9. "Interested party" means the county auditor of any county located in whole or in part within the boundaries of the basin.

Subd. 9. "Interested party" means any person having an interest in the subject matter pending or involved, and shall include any official of any state agency or subdivision of the state.

Subd. 10. "Project" or "improvement" means any work or works for construction, maintenance, repairs, study or studies undertaken by the commission.

114A.03 Purpose and Intent. Subdivision 1. The southern Minnesota rivers basin commission is hereby established to serve as the regional organization for guiding the creation and implementation of a comprehensive environmental conservation and development plan for the basin. All state departments and agencies are hereby directed to cooperate with the commission, and to assist it in the performance of its duties. In cooperation with all federal agencies, including but not limited to the United States departments of agriculture and interior and the corps of engineers, all state agencies, departments, and commissions, including but not limited to the department of natural resources, Minnesota geological survey, water resources board, state planning agency, department of transportation, soil and water conservation commission, pollution control agency, department of economic development, department of agriculture and the institute of agriculture of the University of Minnesota, and local governments and citizens within the basin, the commission shall initiate, coordinate and prepare its overall comprehensive environmental conservation and development plan. The Minnesota soil and water conservation commission and local soil and water conservation districts and watershed districts within the basin shall provide technical assistance to the commission in the creation and implementation of the plan. Upon the request of the commission, the governor or the legislature may require any other department or agency of the state to furnish assistance, technical or otherwise, to the commission in the performance of its duties or in the exercise of its powers authorized by law. The plan may include, but is not limited to, planning for the following purposes:

(1) Control or alleviation of damages by flood waters;
(2) Improvement of stream channels for handling of surface waters, navigation, and any other public purposes;
(3) Reclaiming or filling of wet and overflowed lands;
(4) Regulating the flow of streams and conserving the waters thereof;
(5) Diverting or changing watercourses in whole or in part;
(6) Providing and maintaining water quality and supply for municipal, domestic, industrial, recreational, agricultural, aesthetic, wildlife, fishery, or other public use;
(7) Providing for sanitation and public health and regulating uses of streams, ditches, or watercourses for the purpose of disposing of waste and maintaining water quality;
(8) Repair, improvement, relocation, modification, consolidation, or abandonment in whole or in part of previously established public drainage systems within the territory;
(9) Imposition of prevention or remedial measures for the control or alleviation of land and soil erosion and siltation of watercourses, or bodies of water affected thereby;
(10) Regulation of improvements and land development by abutting landowners of the beds, banks, and shores of lakes, streams, watercourses and marshes by permit or otherwise in order to preserve the same for beneficial use; such regulation to be in accordance with state department of natural resource standards and criteria;
(11) Regulation of construction of improvements on and prevention of encroachments in the flood plains of the rivers, and the lakes, marshes and streams of the basin; such regulation to be in accordance with state department of natural resources standards and criteria.

Subd. 2. Implementation of plan. Upon reviewing and approving the overall comprehensive environmental conservation and development plan for the basin, the commission shall be the coordinating agency for the implementation of the plan and it may designate and request any local unit of government, including but not limited to counties, cities, soil and water conservation districts and watershed districts, to initiate, implement and carry out any phase, project or improvement provided for in the commission's plan. The commission may engage in public education programs.

114A.04 Commission. Subdivision 1. Commissioners, appointment, compensation. The commission shall consist of eleven members, all of whom shall be residents within the basin. Five members, who may be county commissioners, shall be elected by an advisory council,

which shall consist of one person appointed by the county board of each of the counties lying wholly or partly within the basin. Each of these members shall serve fixed terms of not to exceed three years, as determined by the advisory council, and vacancies of these members shall be filled by the advisory council. Five members shall be appointed by the governor with two original members appointed for a term of one year and two members appointed for two years and one member appointed for three years. Thereafter, the term for each member appointed by the governor shall be for a period of three years, and until his successor is appointed and qualified. The last remaining member of the commission shall be its chairman who shall be appointed by and serve at the pleasure of the governor. The compensation of the members of the commission shall not exceed $35 per day, and each member shall be entitled to reimbursement for all traveling and other expenses necessarily incurred in the manner provided for state employees.

Subd. 2. Officers, procedures, time and place of meeting. Except for its chairman, the commission shall select from among its members all necessary officers for terms of one year. The commission shall adopt, and from time to time amend its own rules of procedure. The commission shall determine the place and time of its meeting. The commission shall meet with not less frequency than once every month.

Subd. 3. Seal, records, annual report. The commission shall adopt a seal and shall keep a record of all proceedings, minutes, official papers and all other business transacted or actions taken by the commission, which record shall be, at all reasonable times, open to public inspection. The commission annually shall file a report of the progress of the comprehensive plan for the preceding year with each regional development commission in the basin.

114A.05 Commission; Powers, Duties. In order to give effect to the purposes of Laws 1973, Chapter 609, the commission shall have the power to adopt guidelines and regulations to coordinate natural resources management so as to prevent the pollution, impairment or destruction of the air, water, land or other natural resources located within the basin, assuring that the commission's activities will not unnecessarily overlap or conflict with any similar activities authorized by the legislature and performed by established agencies. The commission shall develop and coordinate an efficient system whereby the political subdivisions, commissions, departments, agencies, local units of governments and other authorities within the basin having the necessary powers may carry out, in an efficient and coordinated manner, all activities reasonable and necessary to prepare and approve the commission's comprehensive environmental conservation and development plan for the basin and thereafter to foster and promote its implementation by the various federal, state and local units of governments thereby affected.

114A.06. Perpetual Existence. The southern Minnesota rivers basin commission created hereunder shall have perpetual existence, with the power to sue and be sued.

114A.07 Government Units to Cooperate. Each local and regional governmental unit, its officers and employees, and each regional development commission, its officers and employees, shall cooperate with the commission in accomplishing its purposes as established by sections 114A.01 to 114A.09. Such unit may aid the commission by furnishing staff, services, property, or financial support to the commission.

114A.08 Budget. The commission shall, prior to each session of the legislature, submit a budget request for funds to be used for its general expenses to accomplish the purposes of sections 114A.01 to 114A.09. Said budget request shall be presented by the commission to the governor and the legislature of the state of Minnesota on or before November 15 of each year that the legislature is in session.

114A.09 Pollution Control Agency. Nothing in sections 114A.01 to 114A.09 shall be construed to in any way supersede the powers and duties of the Minnesota pollution control agency under chapters 115 and 116, or to affect the validity of any standard, regulation, stipulation, order or permit heretofore or hereafter adopted or issued pursuant thereto.

MINNESOTA RIVER BASIN REPORT

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CHAPTER I

INTRODUCTION

I — INTRODUCTION

A. STUDY BACKGROUND

In June 1972, the Upper Mississippi River Basin Coordinating Committee submitted the completed Upper Mississippi River Comprehensive Basin Study to the United States Water Resources Council. The study presented a framework program for the development and management of water and related land resources in the Upper Mississippi River Basin.

Included in the report was a summary of problem areas recommended for further study. The Minnesota River Basin was identified as needing investigation of water quality, flood and sediment damage, water supply, commercial navigation, recreational opportunity, and environmental preservation. The proposal suggested that a regional or river basin plan, based on guidelines established by the Water Resources Council, be coordinated by a river basin commission responsible for focusing on middle-term (next 10-15 years) needs and desires. These recommendations confirmed the need for the Type IV river basin study already being conducted.

B. NEEDS FOR THE STUDY

Due to recurring flood damage and other problems such as pollution, erosion, deficiencies in recreation and conservation opportunities, and the continuing practice of developing solutions to various water and related land resource problems without considering the impact on the total basin, the Minnesota State Soil and Water Conservation Board (then referred to as the Minnesota State Soil and Water Conservation Commission), in 1969, requested the cooperation of the United States Department of Agriculture to participate in a coordinated study of the basin for water and related land resource development. The State Soil and Water Conservation Board determined that a study was needed to:

1. Identify the present and projected water and related land resource problems and needs.
2. Quantify and qualify data collected.
3. Identify project opportunities for development based on urgency of need.

Under congressional authority, the United States Department of Agriculture (USDA) was funded to begin study of the Minnesota River Basin in July 1970. Studies were needed of the basin's water and related land resource development needs and potential, including watershed protection, land treatment and management, flood prevention, water quality control, water supply, recreation, irrigation, drainage, and fish and wildlife enhancement. Special emphasis on environmental quality and its impact on resource use were requested.

To insure that the needs of the river basin were identified, the United States Department of Agriculture requires participation and involvement from the state and local level to guide the planning process. The Minnesota State Legislature was confronted by requests to solve the flooding problems of the Minnesota River that were vividly highlighted by the severe spring floods of 1965 and 1969. The legislature recognized the need for an organization specifically assigned to coordinate water resource development in the basin. During the 1971 Minnesota Legislative Session, the Southern Minnesota Rivers Basin Commission was created and charged with developing and implementing a comprehensive environmental conservation and development plan for the Minnesota River Basin.

C. OBJECTIVES

The objectives of the USDA's participation in this study is to identify alternatives for the orderly development of water and related land resources in upstream waterbeds and determine

the effect of upstream developments on downstream problems. USDA objectives include development of data on the needs and potentials for:

1. Alleviation of floodwater and sediment damage
2. Proper land treatment and management
3. Agricultural, municipal, and industrial water supply
4. Water quality management
5. Recreation
6. Fish and wildlife enhancement
7. Drainage and irrigation
8. Environmental quality improvement

The basin-wide comprehensive water and related land resource plan was developed and based on problems and needs identified by local, regional, and state organizations. The Southern Minnesota Rivers Basin Commission coordinated the input and based the plan selection on alternative proposals developed by the river basin planning staff of the Department of Agriculture.

D. BRIEF DESCRIPTION OF STUDY AREA

The Minnesota River Basin is located in the southern third of the State of Minnesota. The drainage area of the basin includes about 16,770 square miles; 14,840 in Minnesota, 1,610 in South Dakota, and 320 in Iowa. The basin includes all or parts of 37 counties in Minnesota, three counties in Iowa, and six counties in South Dakota.

Most of the land in the basin is privately owned. Less than 1% is publicly owned which is primarily parks, waysides, public forests, and wildlife management areas. The basin lies within the Central Feed Grains and Livestock Land Resources Region, and is predominantly rural. Corn, soybeans, and small grain production are the principle agricultural activities. Dairy farming and livestock feeding are also quite extensive. Industrial development is closely associated with industries which depend upon agriculture for raw materials. There are no large manufacturing centers. However, a number of plants are engaged in poultry packing and food processing.

E. STUDY AUTHORITY

The Southern Minnesota Rivers Basin Commission was created by the Minnesota Statutes, Chapter 705, Laws of 1971, to coordinate resource planning in the basin. The United States Department of Agriculture is participating in the study under the authority contained in Section 6 of PL83-566, authorizing the Secretary of Agriculture in cooperation with other federal, state, and local agencies, to make investigations and surveys of the watersheds of rivers and other waterways as a basis for development of coordinated programs.

The Secretary of Agriculture designated the Soil Conservation Service to provide leadership in carrying out the department's responsibilities in conducting the study. The Forest Service and the Economic Research Service participate under provisions of a Memorandum of Understanding dated April 15, 1968 (RB-2, Rev., dated May 6, 1968).

F. NATURE AND INTENSITY OF INVESTIGATIONS

Information from previous studies and various federal, state, and private sources was used to the extent possible. All activities were coordinated by the Southern Minnesota Rivers Basin

Commission (SMRBC), and the USDA Field Advisory Committee (FAC). The SMRBC meets monthly, and the FAC meets three times a year. Numerous work group meetings were held during the course of the study.

The basin was divided into four study areas for investigative purposes. Local policy committees were formed under SMRBC guidance in each study area. These policy committees provided local input and guidance on investigations in their respective areas.

Investigations in each study area were done in two phases. Phase I consisted of identifying problems and needs, and inventorying the natural resources. Phase II activities consisted of specific investigations designed to formulate alternative solutions, analyze the alternatives, and make recommendations on the most feasible solutions.

The main tools used in collection of Phase I data were questionnaires and inventory forms. Questionnaires were completed by policy committees, state agencies, and interested citizens. Inventory forms were completed by SCS district conservationists. Field trips by USDA river basin staff were made in all counties.

Phase II activities resulted in six watershed evaluation reports, and two reports on flooding over large areas. Additional data and summaries of investigations were given to each concerned policy committee and the SMRBC.

The USDA 1967 Conservation Needs Inventory reports for Minnesota, Iowa, and South Dakota, were updated and established the basis for determining conservation treatment needs, watershed delineations, and land use. The Economic Research Service accumulated data and made projections regarding population, income, employment, and agricultural production.

Existing programs were identified and evaluated. Investigations as to the adequacy of existing programs were made. The Minnesota Department of Natural Resources furnished data on recreation and fish and wildlife resources. Minnesota Department of Economic Development furnished community profiles on selected communities in the basin. The U.S. Army Corps of Engineers' furnished data on main stem flood control and flood prevention reservoirs.

G. STUDY ORGANIZATION

The Soil Conservation Service, Forest Service, and Economic Research Service, were the USDA agencies authorized and funded to participate in the study of the Minnesota River Basin. USDA personnel were guided by the Field Advisory Committee. Inventories and alternative investigations were achieved by USDA personnel.

All activities were reviewed at Field Advisory Committee meetings and SMRBC meetings. Specific investigations, inventories, and findings were reviewed with local policy committees in the four study areas.

Existing data and reports from other agencies were obtained and utilized in the study. The selected plan discussed in Chapter VIII was developed by the SMRBC with technical guidance furnished by the USDA Planning Staff personnel. This report is being distributed by the SMRBC.

H. REPORT USES

This report will be used by the State of Minnesota to:

1. Help formulate the Minnesota River Basin portion of the State Land and Water Resource Plan.

2. Assist the USDA in making the most effective use of its' Land and Water Conservation Development Program.

3. Serve as a guide in coordinating water and related land resource development programs and projects of local, state, and federal agencies, and private groups and individuals.

4. To aid in setting priorities for water resources development within the Minnesota River Basin.

The identification of problems, needs, and opportunities presented in this report can be one of the tools used in planning for optimum water and related land resources development. This report can eliminate many of the conflicts usually encountered in the planning process.

The basic data collected and used in this study is on file at the Soil Conservation Service, Room 266, Federal Building, 316 North Robert Street, St. Paul, Minnesota 55101.

I. ACKNOWLEDGMENT

For the cooperation and assistance provided in the collection and assembly of data for this report, appreciation is expressed to the following:

U.S. Department of Agriculture
- Soil Conservation Service
- Economic Research Service
- Agricultural Extension Service
- Forest Service
- Farmers Home Administration
- Agricultural Stabilization and Conservation Service

U.S. Department of Interior
- Bureau of Outdoor Recreation
- Fish and Wildlife Service
- U.S. Geological Survey

U.S. Department of Defense
- Army Corps of Engineers

State Agencies
- Minnesota Water Resource Council
- Department of Natural Resources – South Dakota and Iowa
- Minnesota Pollution Control Agency
- Minnesota Department of Natural Resources
- Minnesota Department of Economic Development
- Minnesota State Planning Agency
- Minnesota Historical Society
- Minnesota Soil and Water Conservation Board

Other
- Soil and Water Conservation Districts
- University of Minnesota
- County Governmental Officials
- Local Residents
- Water Resources Board

CHAPTER II

ENVIRONMENTAL SETTING AND BASIN RESOURCES

A. LOCATION

The Minnesota River Basin, an area of 16,770 square miles (10,732,000 acres), includes all or parts of 37 counties in Minnesota, six in South Dakota, and three in Iowa. (See location map and Table II-1, Area by County, State, and Study Area.)

The Minnesota River Basin is part of the Upper Mississippi Water Resources Region. The Little Minnesota River (headwaters of the Minnesota River) drains the eastern slope of the Dakota foothills in South Dakota, approximately 30 miles west of the Minnesota border, and flows southeasterly to Big Stone Lake. The Minnesota River flows southeasterly from Big Stone Lake to Mankato where it turns and flows in a northeasterly direction to its confluence with the Mississippi River in Minneapolis-St. Paul.

The basin was divided into four study areas: Study Area I – Blue Earth River, Study Area II – Upper Minnesota River, Study Area III – Headwaters Minnesota River, and Study Area IV – Middle and Lower Minnesota River. Table II-1 shows the basin breakdown by study area, counties, and states.

B. CLIMATE

The Minnesota River Basin has a continental climate. The basin is subject to frequent outbreaks of continental polar air throughout the year. Cold waves are usually of the boreal type – rushing southward over the area from the continental arctic regions. Occasional periods of high temperature occur during summer when warm air pushes northward from the Gulf of Mexico and the southwestern United States. When Pacific Ocean air masses move across the western United States, they produce comparatively mild and dry weather in all seasons.

Although total precipitation is important, its distribution during the year is even more significant. Mean annual precipitation ranges from 31 inches at the Iowa-Minnesota border in Study Area I to 20 inches in the South Dakota portion of the basin. Normal rainfall during the cropping season ranges from 20 inches at the Iowa-Minnesota border to 14 inches in South Dakota. Approximately two-thirds of the annual precipitation occurs during the cropping season. Figures II-2 and II-3 indicate the distribution of annual normal and growing season normal precipitation, respectively.

Seasonal snowfall averages 32 inches in South Dakota to 48 inches in the Iowa portion of the basin, and accounts for 30 percent of total precipitation. Table II-2 shows snowfall extremes. (Snowcover of one inch or more over the basin averages 90 days annually.) Because snowfall varies so much from the normals, extremes are important.

Average annual lake evaporation ranges from 30" to 36". Annual pan evaporation ranges from 40" to 48" a year. The actual daily evapotranspiration (evaporation from land and plant surfaces), or ET, averages about 0.15 inch of water daily during the months of June, July, and August. Row crops average approximately 20 inches of ET in a year. However, the average annual potential ET, assuming adequate soil moisture at all times, is near 24 inches.

Mean annual Fahrenheit temperatures range from 42° in Study Area III to 46° along the Iowa border in Study Area I. The July mean Fahrenheit temperature is 74° and the January mean Fahrenheit temperature is 13° for the basin. The freeze-free (air temperature greater than 32°F) growing season generally starts about the second week of May and ends during the first week of October. The basin area near the Iowa-Minnesota border has the longest growing season – approximately 155 days. The northern-most area of the basin in South Dakota has approximately 130 days freeze-free period. The soil freezes about the first week of December and thaws about mid-April. Average maximum freeze depth in the basin is from three to four feet, exclusive of forested regions where the freezing depth is ordinarily shallower.

TABLE II-1. AREA BY COUNTY, STATE AND STUDY AREA, MINNESOTA RIVER BASIN, IN SQUARE MILES[1]

State	County	Study Area I	Study Area II	Study Area III	Study Area IV	TOTAL Basin	% of County in Basin
Minnesota	Big Stone			422.1		422.1	81
	Blue Earth	570.1	130.9		49.9	750.9	99
	Brown	59.1	558.9			618.0	100
	Carver				226.7	226.7	61
	Chippewa			357.4	227.6	585.0	100
	Cottonwood	193.8	289.6			483.4	75
	Dakota			71.7	71.7	71.7	12
	Douglas			330.0		330.0	46
	Faribault	718.0				718.0	100
	Freeborn	152.3				152.3	21
	Grant			200.2		200.2	35
	Hennepin				112.6	112.6	19
	Jackson	84.8				84.8	12
	Kandiyohi			138.0	269.6	407.6	47
	Lac Qui Parle		762.1	12.9		775.0	100
	LeSueur	2.4			324.1	326.5	70
	Lincoln		457.1			457.1	85
	Lyon		698.0			698.0	98
	McLeod				64.9	64.9	13
	Martin	554.3				554.3	76
	Murray		110.8			100.8	15
	Nicollet				459.0	459.0	100
	Otter Tail			230.0		230.0	10
	Pipestone		25.7			25.7	6
	Pope			618.4		618.4	86
	Redwood		874.0			874.0	100
	Renville				726.3	726.3	74
	Rice				44.0	44.0	9
	Scott				341.6	341.6	94
	Sibley				575.4	575.4	98
	Steele	37.4				37.4	9
	Stevens			429.9		429.9	75
	Swift			748.0		748.0	100
	Traverse			36.0		36.0	6
	Waseca	343.8				343.8	81
	Watonwan	437.0				437.0	100
	Yellow Medicine		758.0			758.0	100
Minnesota Totals	**37 Counties**	**3153.0**	**4665.1**	**3522.9**	**3493.4**	**14834.4[2]**	–
Iowa	Emmet	12.9				12.9	3
	Kossuth	237.8				237.8	24
	Winnebago	72.7				72.7	18
Iowa Totals	**3 Counties**	**323.4**	–	–	–	**323.4[2]**	–
South Dakota	Brookings		23.8			23.8	3
	Deuel		334.0			334.0	52
	Grant		307.2	248.4		555.6	81
	Marshall			53.2		53.2	6
	Roberts			621.6		621.6	56
	Codington		23.0			23.0	3
South Dakota Totals	**6 Counties**	–	**688.0**	**923.2**	–	**1611.2[2]**	–
Minnesota River Basin Totals	**46 Counties**	**3476.4**	**5353.1**	**4446.1**	**3493.4**	**16769.0**	–

[1]Source: 1967 Conservation Needs Inventory

[2]The portion of the basin within Minnesota is 14,834.4 square miles (88%).
The portion of the basin within Iowa is 323.4 square miles (2%).
The portion of the basin within South Dakota is 1611.2 square miles (10%).

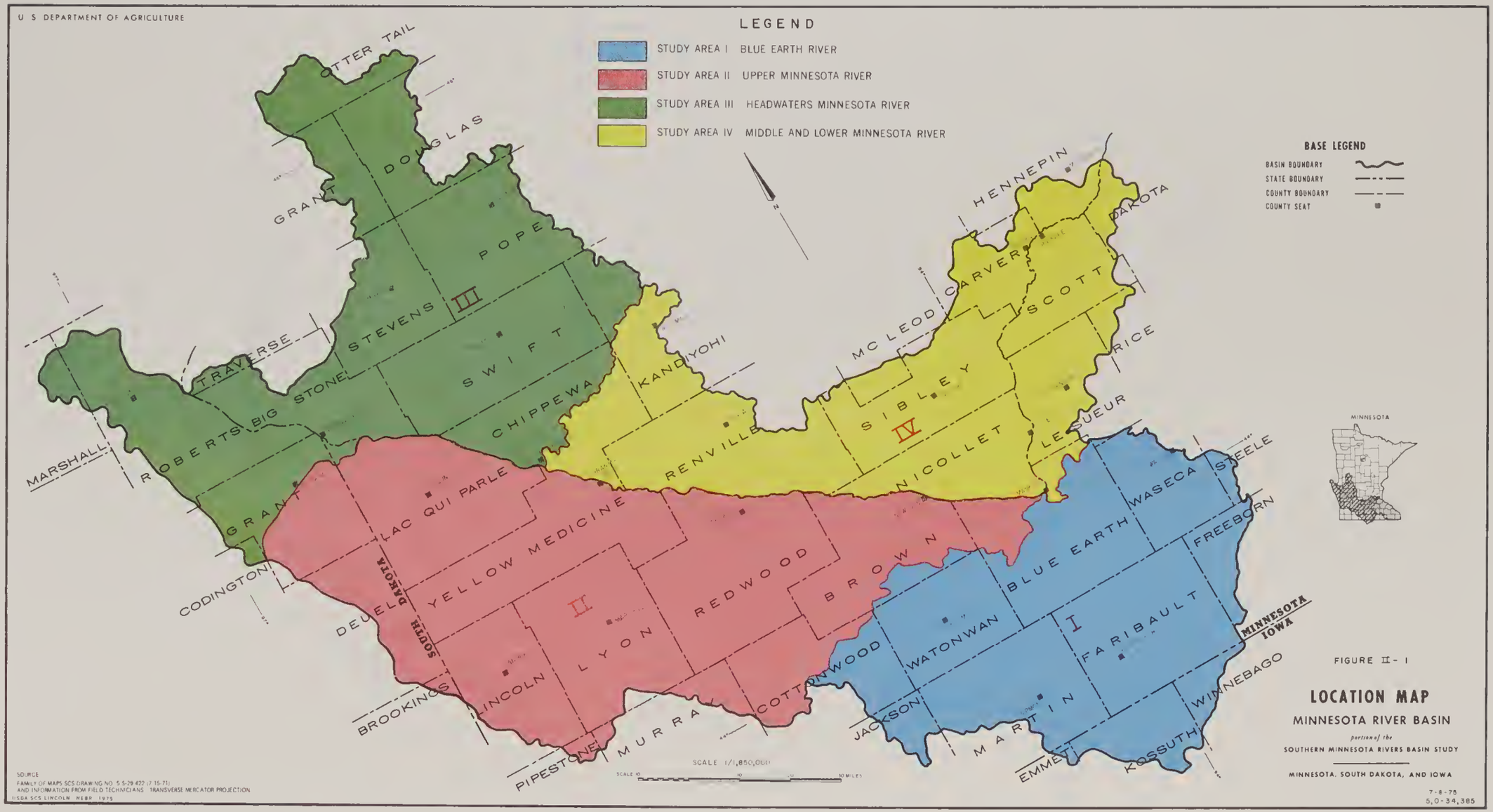


FIGURE II- 1

LOCATION MAP

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

7-8-75

5,0-34,385

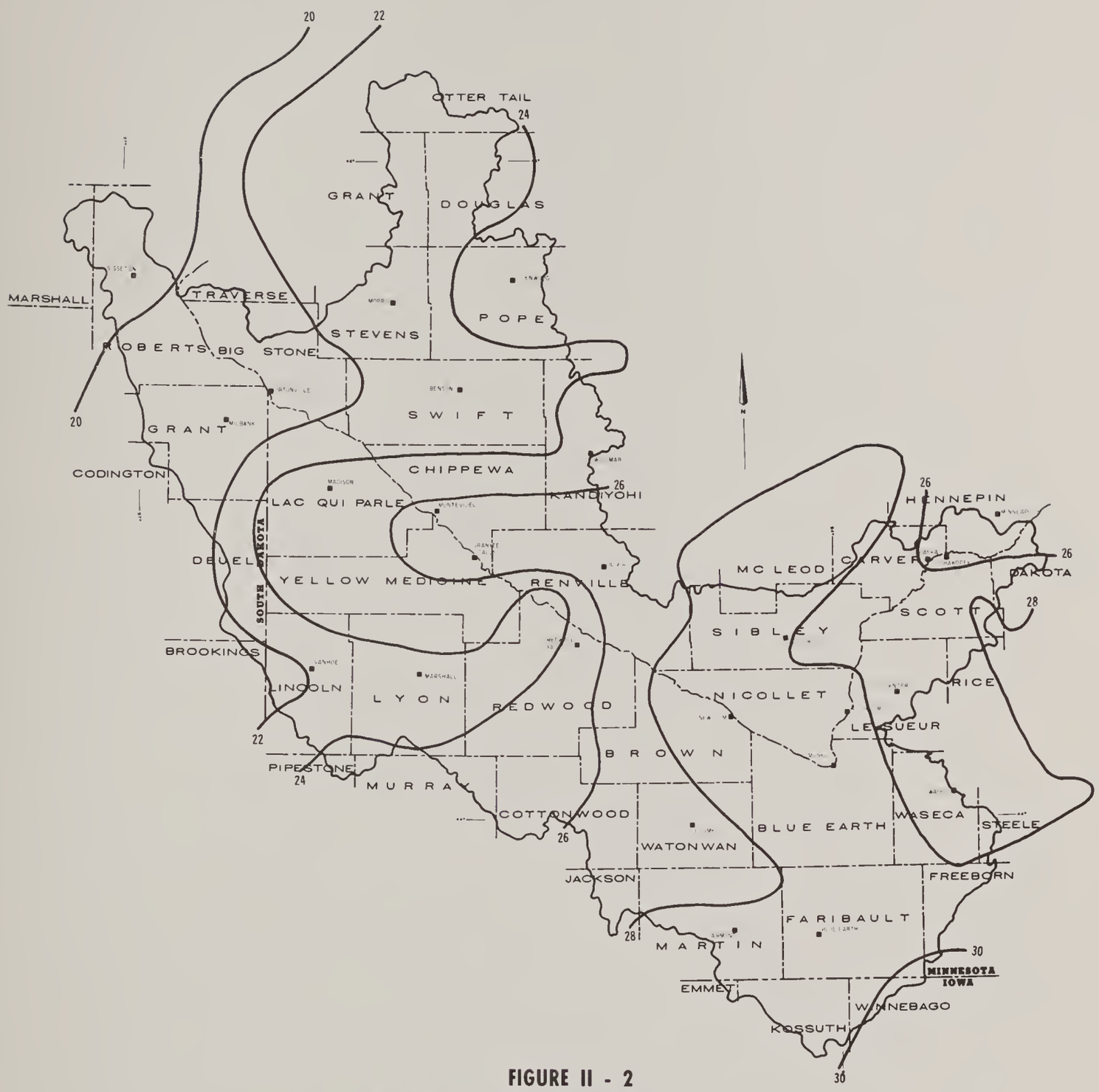


FIGURE II - 2
ANNUAL NORMAL PRECIPITATION (INCHES)

-SCS-LINCOLN, NEBR. 1976

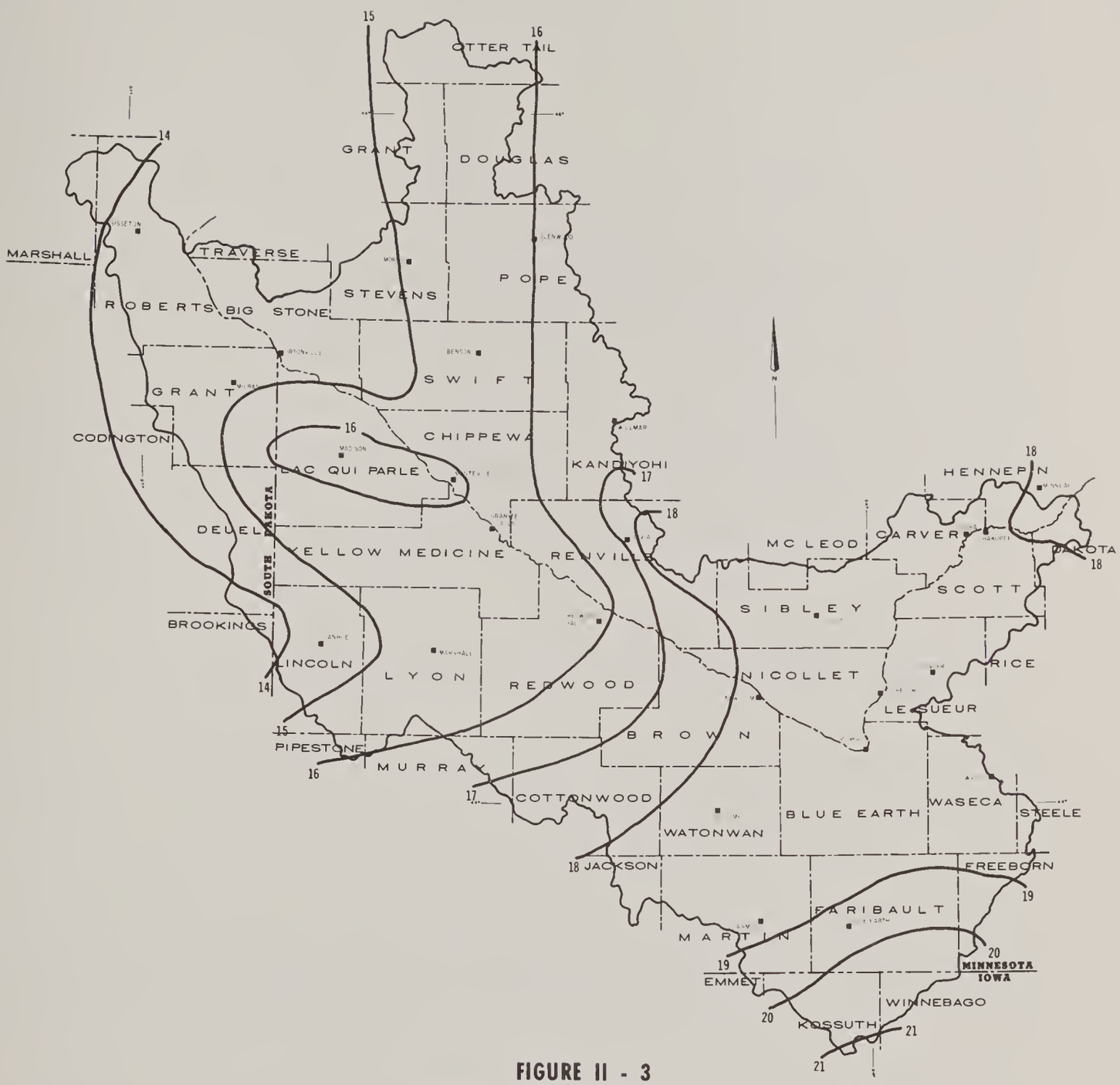


FIGURE II - 3
GROWING SEASON (MAY-SEPTEMBER)
NORMAL PRECIPITATION (INCHES)

USDA-SCS-LINCOLN, NEBR 1576

TABLE II-2. MONTHLY SNOWFALL EXTREMES IN INCHES FOR THE NORMAL PERIOD (1931-1960), MINNESOTA RIVER BASIN

	Location				
	Study Area III	(High)	Study Area I	Study Area III	(Low)	Study Area I
January	23.0		22.9	0.3		1.4
February	18.3		27.9	0.3		0.3
March	36.0		33.9	1.5		2.4
April	11.7		8.8	0		0
May	4.3		1.6	0		0
June	0		0	0		0
July	0		0	0		0
August	0		0	0		0
September	2.6		7.1	0		0
October	7.1		1.9	0		0
November	20.4		17.3	0		0
December	14.3		23.0	0.2		0.3

Conditions of moderate droughts or worse are expected at least once in four to five years except in the western portion of the basin where they occur about once in every three years. Severe or extreme drought conditions occur on the average of once in every eight to nine years, except in the southwest portion of the basin where they occur about once in every six years. Generally, the more severe droughts tend to persist or recur several years in succession.

Thunderstorm winds are a frequent cause of damage to property and crops throughout the basin. Their annual frequency during the growing season is about once in 45 days. Eighty percent or more of these storms occur during the heavier rainfall months — May through September. Damaging local windstorms, tornadoes, hail, and heavy rains occur with the stronger and more well-developed thunderstorms. The most frequent occurrence of tornadoes is between May and July with June being the most prevalent month for tornadoes.

C. GEOLOGY AND PHYSIOGRAPHY

The basin is within the "western lake section" central lowland province of the interior plains physical division of the United States, which is characterized by young glaciated plains, moraines, lakes, and lacustrine plains.

The surface materials and features in the basin are a product of recent glaciation. Glacial materials cover most of the sediment and ancient bedrock in the basin. Ancient bedrock and younger sedimentary rock are exposed in a few places in the Minnesota River Valley. This bedrock is among the oldest rock known on earth, dating back over three billion years.

The topography over the major portion of the basin is flat to gently undulating. Subdued hills and ridges border the very outer limits of the basin on the north, southwest, and east. Watershed divides over most of the rest of the basin are indistinct. The hilly areas rise about 2,000 feet, with the highest elevation of 2,100 feet in Roberts County, South Dakota. The outlet of the basin has an elevation of 700 feet which accounts for 1,400 feet of total relief in the basin.

The natural drainage pattern was established by the rivers and valleys formed by glacial meltwaters. The present low gradient streams occupy these older systems practically without modification. The present drainage network is poorly defined except for the major rivers. Considerable areas have no outlet. Interior watershed divides are indistinct and cross-over flooding is a common occurrence. Channel construction over the last half century has established a manmade drainage network over the lower two-thirds of the basin. Large areas in the northeast and southwest portion of the basin do not have major channels with adequate capacity.

Water areas account for 2.5 percent of the basin. A chain of lakes exists along the upper reaches of the Minnesota River from Lac qui Parle reservoir near Montevideo to Marsh Lake and Big Stone Lake at Ortonville, Minnesota. Smaller pothole and glacial lakes occur along the watershed boundaries. The Pomme de Terre and Chippewa River headwaters in the northern portion of Study Area III contain abundant lakes. Smaller concentrations of lakes occur along the southwest fringe of the basin in the boundary area between Minnesota and South Dakota. The flat to gently undulating central portion of the basin has very few lakes.

The valley, cut by melting glacial ice and presently occupied by the Minnesota River, provides an aesthetic view in contrast to the bordering flat plains. The scenic morainic hill region northwest of Willmar is highly valued for its rolling wooded hills, lakes, and wildlife marshes. The high Coteau des Prairie sloping escarpment along the southwest side of the basin provides a scenic overview of the farmland east of the escarpment.

Mineral resources in the Minnesota basin, in order of importance, consist of dimension stone, sand and gravel, crushed stone, shales, and clay. Mineral reserves appear sufficient to meet projected demands.

D. LAND RESOURCE AREAS

The Minnesota River Basin is located within the Central Feed Grains and Livestock Region. This land resource region is further broken down into land resource areas (LRA).

LRA's are broad geographic areas having similar soil, climatic, geologic, vegetative, and topographic features. The basin is located within portions of two major LRA's: 102-Loess, Till and Sandy Prairies; and 103-Central Iowa and Minnesota Till Prairies. Following is a brief description of each LRA. (See Figure II-4.)

The majority of the western half of the basin is in LRA 102 (Loess, Till, and Sandy Prairies). Chernozem soils developed on calcareous loam till are dominant. Topography is mostly undulating, but ranges from nearly level to hilly. Nearly all land is cultivated. Row crops and small grains are the most common crops. Water and wind erosion are serious problems. Drainage is a problem on wet soils. Typical soils are Barnes and Langhei in the uplands, Flom and Parnell in the lowlands, and Arvilla and Maddock in the outwash (see Appendix A).

The central and eastern portions of the basin are in LRA 103 (central Iowa and Minnesota till prairies). The central portion consists of Brunizem and Humic Gley soils developed on calcareous loam and clay loam till. Topography ranges from nearly level to hilly, but is mostly gently undulating. Nearly all of the area is under cultivation with row crops being the most common crops. The eastern edge of the basin consists of gray-brown Podzolic or gray-brown Podzolic-brunizem intergrade soils developed from Calcareous loam and clay loam till. Topography in this area ranges from undulating to steep. Most of the land is cultivated, most commonly with row crops, hay, and small grains. Erosion is the most serious problem on rolling cropland. Lack of drainage associated with poorly drained soils is also a problem. Typical soils are Clarion, Lester, and Hayden in the uplands, Webster, Dundas, and Glencoe in the lowlands, and Estherville, Hubbard, and Burnsville in the outwash.

E. LAND USE DISTRIBUTION AND MANAGEMENT

Land use varies within the Minnesota River Basin. Data are presented in Tables II-3, 4, and 5, and Figures II-5 and 6, showing the land use for the 10.7 million acres in the basin.

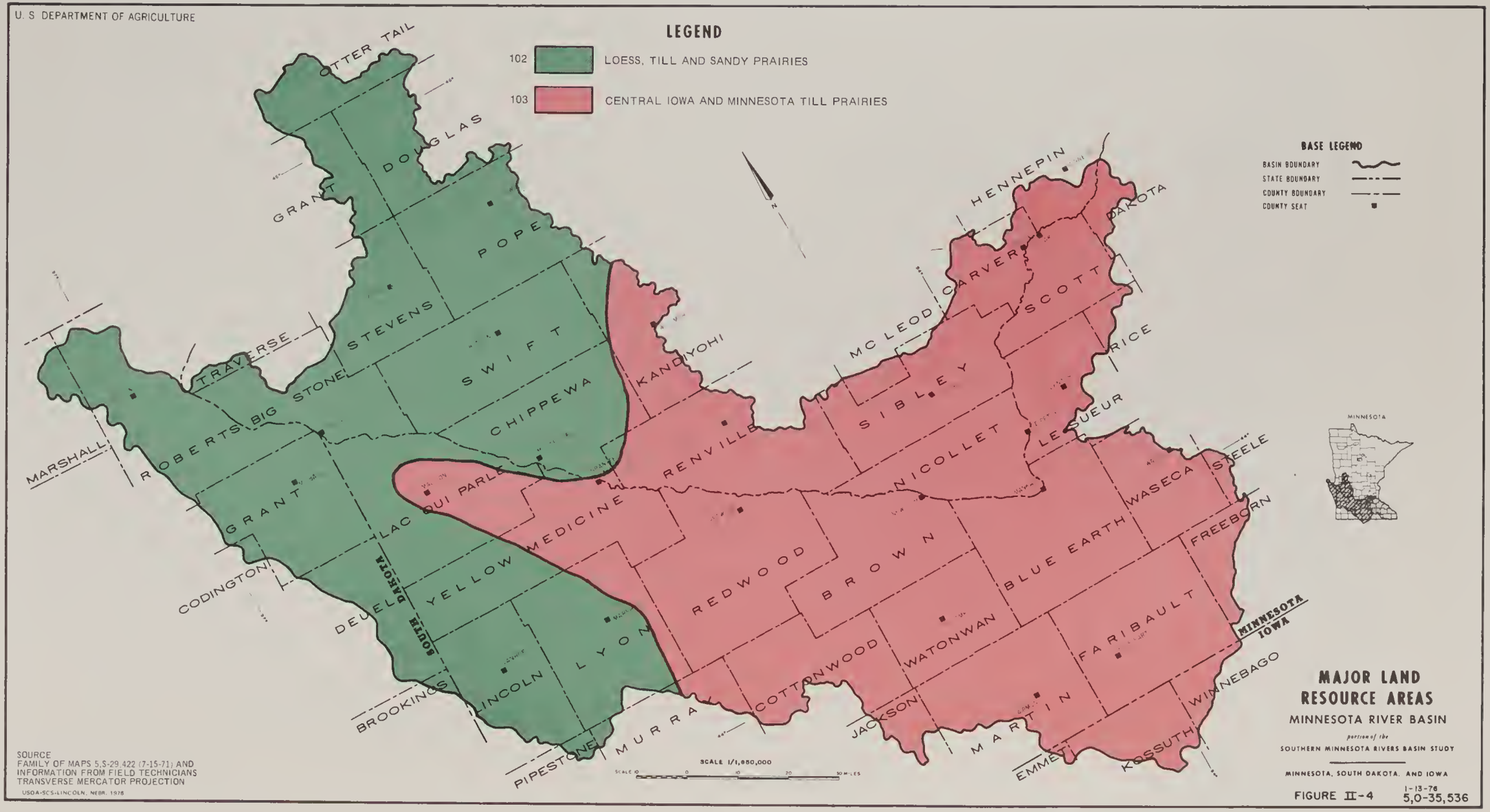

U. S DEPARTMENT OF AGRICULTURE
LEGEND
102 LOESS, TILL AND SANDY PRAIRIES
103 CENTRAL IOWA AND MINNESOTA TILL PRAIRIES
BASE LEGEND
BASIN BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
COUNTY SEAT
OTTER TAIL
DOUGLAS
GRANT
POPE
STEVENS
TRAVERSE
BIG STONE
SWIFT
CHIPPEWA
KANDIYOHI
MARSHALL
ROBERTS
GRANT
LAC QUI PARLE
RENVILLE
MEDICINE
YELLOW
CODINGTON
DEUEL
SOUTH DAKOTA
LINCOLN
LYON
BROOKINGS
PIPESTONE
MURRAY
REDWOOD
BROWN
COTTONWOOD
WATONWAN
JACKSON
MARTIN
FARIBAULT
EMMET
KOSSUTH
MINNESOTA
IOWA
WINNEBAGO
FREEBORN
BLUE EARTH
WASECA
STEELE
NICOLLET
LE SUEUR
SIBLEY
MC LEOD
CARVER
SCOTT
RICE
HENNEPIN
DAKOTA
MINNESOTA
SCALE 1/1,850,000
SCALE 10 0 10 20 30 MILES
SOURCE
FAMILY OF MAPS 5,S-29 422 (7-15-71) AND
INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION
USDA-SCS-LINCOLN, NEBR. 1976
MAJOR LAND
RESOURCE AREAS
MINNESOTA RIVER BASIN
portion of the
SOUTHERN MINNESOTA RIVERS BASIN STUDY
MINNESOTA, SOUTH DAKOTA, AND IOWA
FIGURE II-4
1-13-76
5,0-35,536

FIGURE II-5

TOTAL AREA LAND USE - 1974
MINNESOTA RIVER BASIN

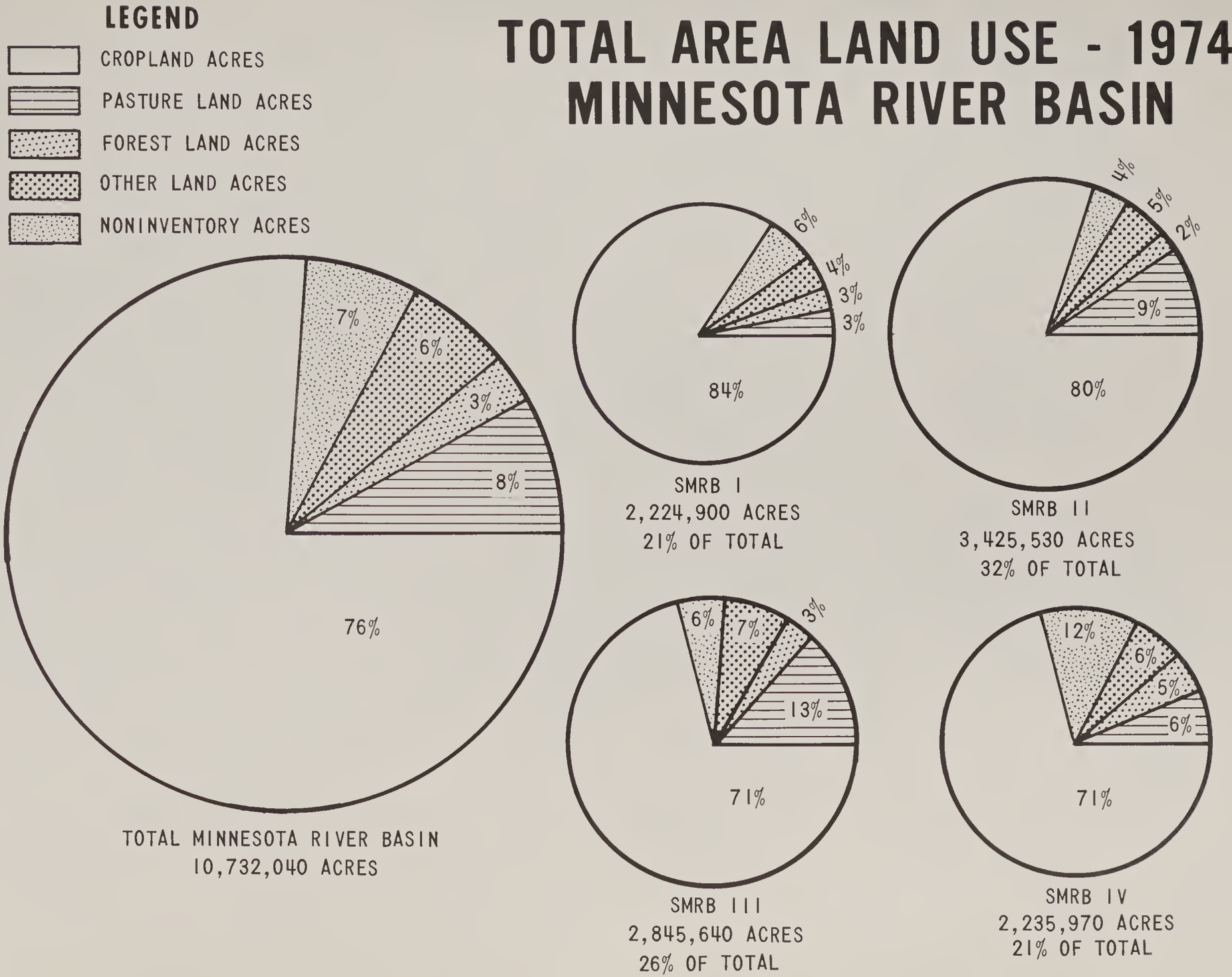


FIGURE II-6

NONINVENTORY LAND USES - 1974
MINNESOTA RIVER BASIN

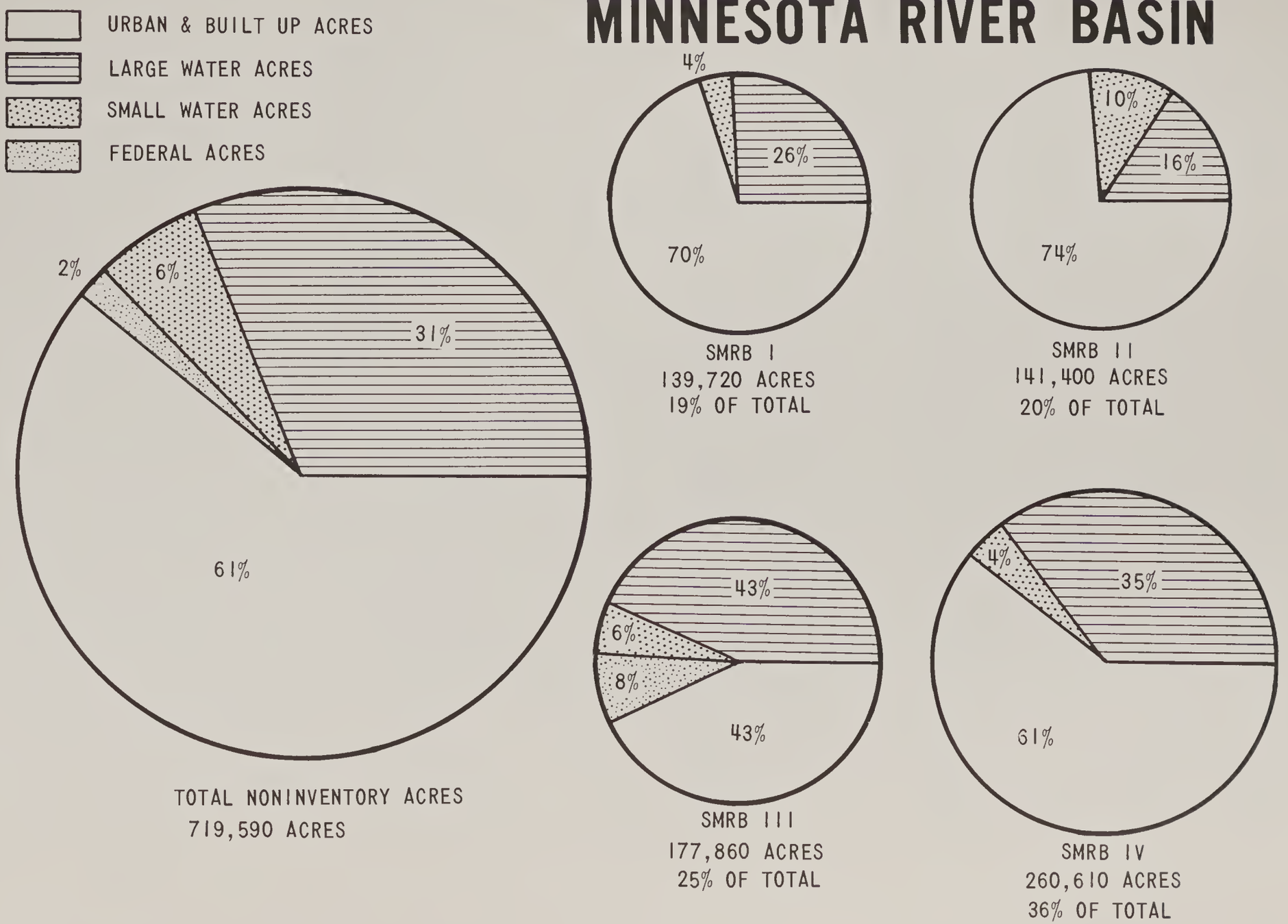


TABLE II-3. TOTAL LAND AREA USE (1974)[1], MINNESOTA RIVER BASIN

Use	Study Area I	Study Area II	Study Area III	Study Area IV	Total Basin
Cropland[2]					
Acres	1,865,530	2,740,790	2,019,090	1,588,780	8,214,190
Percent	84	80	71	71	76
Pasture Land					
Acres	68,370	303,040	355,680	146,610	873,700
Percent	3	9	13	6	8
Forest Land					
Acres	54,990	66,120	86,770	113,990	321,870
Percent	3	2	3	5	3
Other Land					
Acres	96,290	174,180	206,240	125,980	602,690
Percent	4	5	7	6	6
Non-Inventory[3]					
Acres	139,720	141,400	177,860	260,610	719,590
Percent	6	4	6	12	7
TOTAL ACRES	2,224,900	3,425,530	2,845,640	2,235,970	10,732,040
Percent	100	100	100	100	100

[1]Adjusted 1967 Conservation Needs Inventory data.
[2]See Table II-4 for cropland breakdown.
[3]See Table II-5 for non-inventory breakdown.

TABLE II-4. CROPLAND PERCENTAGES (1974)[1], MINNESOTA RIVER BASIN

Crop	Study Area I (Percent)	Study Area II (Percent)	Study Area III (Percent)	Study Area IV (Percent)	Total Basin (Percent)
Corn[2]	46	39	28	39	38
Soybeans	34	26	18	28	26
Oats	4	10	21	6	11
Pasture in Rotation	5	8	9	8	7
Alfalfa Hay	4	6	7	6	6
Small Grains[3]	2	5	10	3	5
Idle[4]	2	3	4	6	4
Other	3	3	3	4	3
TOTAL	100%	100%	100%	100%	100%
Total Cropland Acres	1,865,530	2,740,790	2,019,090	1,588,780	8,214,190

[1]Cropland percentages for 1974 are based on the 1967 CNI data with adjustment estimates made by USDA technicians for shifts in different crops.
[2]Corn includes both corn for grain and corn for silage. Approximately 90 percent of corn grown is harvested as grain and 10 percent harvested as silage.
[3]Small grains are mainly spring wheat, barley, and flaxseed.
[4]Idle cropland has decreased significantly since 1967, especially in Study Areas I and II.

TABLE II-5. NON-INVENTORY USES (1974), MINNESOTA RIVER BASIN

Non-Inventory Use	Study Area I	Study Area II	Study Area III	Study Area IV	Total Basin
Urban and Builtup					
Acres	97,010	104,410	75,520	157,840	434,780
Percent	70	74	43	61	61
Large Water[1]					
Acres	36,000	22,680	75,940	90,830	225,450
Percent	26	16	43	35	31
Small Water[2]					
Acres	6,210	14,270	11,410	11,130	43,020
Percent	4	10	6	4	6
Federal[3]					
Acres	500	40	14,990	810	16,340
Percent	0	0	8	0	2
TOTAL ACRES	139,720	141,400	177,860	260,610	719,590

[1]Large water areas – over 40 acres.
[2]Small water areas – less than 40 acres.
[3]Acres expanded from 1967 CNI. Because of computation method, these figures may not agree with figures elsewhere in this report.

The largest land use is cropland. Corn and soybeans are the major crops (64 percent of the cropland). Study Areas I and II are very dependent on corn and soybean production. Study Area III, the northern most study area, has considerably more small grain production and more water related recreation activity than the other three areas. Study Area IV's land use is similar to Study Areas I and II in the agricultural areas. Study Area IV's eastern portion reflects its location in respect to the urban area of the Twin Cities. Many rural residences and urban related land uses are present.

Idle cropland has decreased significantly since 1967. Higher prices for crops, coupled with the farmers desire to make each acre economically productive, have resulted in "fence-to-fence" production. The removal of the USDA program requirements of conserving base acres, along with expiration of many crop adjustment programs and soil bank agreements, have contributed to this shift. Idle land is more prevalent in Study Area IV as some idle cropland is being held for urban speculative purposes.

1. Agricultural Ownership Patterns

Agriculture is the largest industry in the basin and accounts for 32 percent of all earnings. Approximately 20 percent of the basin's labor force is employed in agriculture.

The *1969 Census of Agriculture* reported 33,906 farms in the basin with an estimated land and building investment of $3.5 billion. Farmers had an additional investment of $682 million in farm machinery and equipment. The value of all farm sales in the basin was nearly $609 million. Approximately two-thirds came from livestock sales and one-third from crop sales. As agriculture holds a dominant position in the basin's economy, much of the economic activity is related to agricultural production and marketing.

The general trend in farm numbers, size, investment, and type of ownership is indicated in Table II-6. Farm numbers have declined 25 percent during the last 15 years while farm size has increased 35 percent. Increased acreages and values per acre have caused average investment in land and buildings to increase more than 150 percent between 1954 and 1969.

The general land tenure trend has been owning land and renting additional land. The number of tenant farmers is declining and currently represents 18 percent of all operators. The proportion of part-time farming has been increasing. Nearly 40 percent of all farm operators work part-time off the farm, and about half of these work more than 100 days per year off their farms.

TABLE II-6. AGRICULTURAL OWNERSHIP TRENDS[1], MINNESOTA RIVER BASIN

	1954	1959	1964	1969
Number of Farms	47,100	43,754	39,053	33,906
Average number acres per farm	208	222	249	282
Average value land and buildings per farm (dollars)	$29,952	$45,066	$54,033	$79,242
Average value land and buildings per acre (dollars)	$ 144	$ 203	$ 217	$ 281
Full owner operators (number)	22,415	20,432	18,213	16,987
Part owner operators (number)	9,593	9,940	10,718	10,590
Tenant operators (number)	15,009	13,328	10,021	6,329

[1]Source – U.S. Census of Agriculture.

The predominant type of farm in the basin is cash grain, producing corn and soybeans. Cash grain farming predominates in Study Areas I and II where favorable soil and climatic conditions exist for food grain production.

The second most predominant type of farming is livestock farming. Livestock farms (beef-cattle and hogs) account for one-third of the commercial farms and are scattered across the entire basin. The number of dairy farms has declined substantially during the last twenty years. The 5,880 dairy farms remaining are operating mainly in Study Area IV in proximity to the Twin Cities.

Specialized crop farming is important, although the number of farms is small. Production of sweet corn and green peas, and accompanying canning and processing plants, are significant to the basin economy. One-hundred-fifty other field crop farms are reported as raising primarily sugar beets and potatoes.

High levels of management are necessary to economically operate farms in the basin. Average investment per farm in land and buildings is $80,000[1], while average investment in machinery and equipment is $16,000[1]. The large capital investment, plus the necessary operating funds to purchase seeds, feeds, fertilizer, petroleum, and chemical products, require sophisticated financial management. Technical knowledge of agronomic relations and livestock feed rations are necessary. Universities, state and federal agencies, seed companies, fertilizer companies, livestock feed companies, and private researchers provide technical and managerial help to farmers.

2. Forest Land

Most forest land in the Minnesota River Basin is located along natural watercourses. There are also small acreages of forest land on farmsteads and steep slopes. Trees are grown where it is unprofitable or impossible to produce agricultural crops. Forests occur on 3% of the land area. Commercial forest land accounts for 91% of the total forest land. Commercial forest land is forest land which does or can produce crops of industrial wood and which is not withdrawn from timber utilization by statute or administrative regulation.

Table II-7 contains information on the forest in the area, and the treatments needed to improve them. Much of the commercial forest land is poorly managed. Sixty-five percent needs either tree planting or timber stand improvement. Fifty percent of it is grazed. These figures indicate a lack of forest management.

The Minnesota Forest Survey rates forest lands on stocking levels and on current and prospective tree growth. This rating is called area condition and indicates the quality of management. Fifty-five percent of the commercial forest land is rated poor.

[1]Agricultural Census Data.

TABLE II-7. STATISTICS ON COMMERCIAL FOREST LAND ACREAGES FOR EACH STUDY AREA AND A SUMMARY FOR THE ENTIRE BASIN[1]

Quantitative Commercial Forest Land Parameters	Study Area I	Study Area II	Study Area III	Study Area IV	Basin Total
Forested Land					
Total Acres	55,206	66,120	87,100	114,030	322,456
Percent of Study Area	3%	2%	3%	5%	3%
Percent of Forest Land that is Commercial Forest Land	94%	93%	86%	90%	91%
Ownership of Commercial Forest Land					
Private Small Ownership	79%	77%	83%	83%	81%
Public Ownership	21%	23%	17%	17%	19%
Private Forest Industry	–	–	–	–	–
Stand Size (Percent of Commercial Forest Land)					
Sawtimber	32%	27%	35%	33%	32%
Poletimber	37%	38%	37%	36%	37%
Saplings and Seedlings	22%	26%	20%	22%	22%
Non-Stocked	9%	9%	8%	9%	9%
Forest Type (Percent of Commercial Forest Land)					
Aspen-Birch	–	5%	27%	31%	16%
Lowland Hardwoods	42%	65%	25%	23%	39%
Oak	22%	8%	24%	19%	18%
Northern Hardwoods	10%	8%	11%	12%	10%
Other	26%	14%	13%	15%	17%
Volume on Commercial Forest Land All Growing Stock					
Cubic Feet (thousands)	38,129	3,050	31,610	53,400	126,189
Hardwoods	98%	99%	96%	99%	98%
Softwoods	2%	1%	4%	1%	2%
Sawtimber – Board Feet (thousands)	178,893	18,240	99,390	239,170	535,693
Hardwoods	100%	100%	98%	100%	99%
Softwoods	–	–	2%	–	1%
Net Annual Growth and Cut on Commercial Forest Land					
Growing Stock					
Growth Cubic Feet	2,298,000	650,000	1,680,000	2,360,000	6,988,000
Cut Cubic Feet	795,700	180,000	500,000	650,000	2,125,700
Sawtimber					
Growth Board Feet	4,160,000	2,770,000	3,440,000	4,590,000	14,960,000
Cut Board Feet	1,930,000	180,000	1,710,000	2,210,000	6,030,000
Forest Industry					
Number of Primary Processors	9	9	13	19	50
Number of Secondary Processors	7	11	30	27	75

[1]Taken from Minnesota Forest Survey and Minnesota Soil and Water Conservation Needs Inventory.

Despite the lack of good forest land management, the basin does contain a good supply of saleable timber. Thirty-two percent of the commercial forest land is stocked with sawtimber size trees. The net annual growth of the sawtimber is more than twice as large as the net annual cut of sawtimber. Sawtimber is not being harvested because of low price and inadequate markets for forest products in the basin. There are only 50 primary and 75 secondary processors of wood in the basin, and most of them are small volume users.

3. Wetlands

Wetlands are classified according to the criteria in the United States Department of the Interior Publication *Wetlands of the United States,* Fish and Wildlife Circular 39. A brief description of the wetland types found in the basin are as follows:

Type II – Inland fresh meadows: The soil usually is without standing water during most of the growing season, but is waterlogged within at least a few inches of its surface. Vegetation includes grasses, sedges, rushes, and various broad-leaved plants.

Type III – Inland shallow fresh marshes: This is an area where the soil is normally waterlogged during the growing season. It is often covered with as much as six inches of water. Typical vegetation consists of grasses, sedges, smartweed, cattails, arrowheads, and pickerelweed. Common representatives in the basin are reed, whitetop, rice cutgrass, carex, and giant burreed.

Type IV – Inland deep fresh marshes: The soil is covered with six inches to three feet or more of water during the growing season. Vegetation includes cattails, reeds, bulrushes, spikerrushes, and wild rice.

Type V – Inland open fresh water: Shallow ponds and reservoirs are included in this type. Water is usually less than 10 feet deep and is fringed by a border of emergent vegetation. Vegetation, if any, is predominantly submergent.

Type VI – Shrub swamps: The soil is usually waterlogged during the growing season, and is often covered with as much as six inches of water. Vegetation includes alders, willows, buttonbush, dogwoods, and swamp-privet.

Wetlands of ten acres or larger (Types II-VI)[1] within the Minnesota River Basin total approximately 215,000 acres (see Table II-8). Numberous additional acres of smaller wetlands are scattered throughout the prairie pothole portion of the basin.

Types III and IV wetlands comprise 70 percent of the estimated wetland acreage with 42 percent occurring in Study Area III, and 31 percent in Study Area IV. The fact that the basin contains more than 74,000 acres of dry or drained basins reflects the trend to more intensive land use. Study Area II contains 40 percent of these dry or drained acres.

Preservation and management of wetlands for wildlife has received top priority from the states of Minnesota, South Dakota, Iowa, and the United States Fish and Wildlife Service. Total wetland acres preserved or managed by the state and federal agencies are approximately 64,000 (see Table II-9). Study Area III contains 68 percent, and Study Area II 22 percent of those combined wetland acres. Within the Minnesota River Basin, 208,500 acres are contained in state wildlife management or federal waterfowl production areas. Wetlands represent about 30 percent of those acres.

4. Land Capability Classes and Soil Resource Groups

A land capability classification of soil resources is used to group soils for use, treatment, and management. The capability classification is based on detailed soil surveys beginning with individual soil mapping units which identify each kind of soil and landscape on which it occurs. The broadest category is a "class" which reflects the limitations in the use of the soil. Classes are designated by Roman Numerals I through VIII. Capacility "subclass" is a second category and is used to identify the major problems, including erosion, wetness, and soil limitations due to shallowness or drought. A third category, land capability "unit", represents soils which are suited to the same kinds of vegetation and will respond similarly to a particular use.

[1] As defined in U.S. Fish and Wildlife Service Circular 39.

TABLE II-8. SUMMARY OF WETLANDS 10 ACRES OR LARGER IN THE MINNESOTA RIVER BASIN[1] (MINNESOTA PORTION ONLY)

Wetland Types	Acres				
	Study Area I	Study Area II	Study Area III	Study Area IV	Totals
Dry or Drained Basins	18,348	29,593	8,953	17,618	74,512
Partially Drained Basins, Some Wetland Remains	2,926	1,964	2,817	6,640	14,347
Type II	1,371	157	2,020	2,951	6,499
Type III	3,377	4,201	13,654	9,000	30,232
Type IV	18,158	16,891	44,879	35,840	115,768
Type V	8,430	9,374	15,831	12,241	45,876
Type VI	12	28	93	226	359
Unclassified	357	249	435	1,110	2,151
TOTAL WETLANDS	34,631	34,864	79,729	68,008	215,232

[1]Condensed from files of Minnesota Department of Natural Resources, Lake Survey Data. Adjusted to conform to Circular 39 – Type definitions.

TABLE II-9. WETLANDS OWNED OR MANAGED BY STATE OR FEDERAL AGENCIES

	Acres				
	Study Area I	Study Area II	Study Area III	Study Area IV	Totals
Minnesota					
Federal (USF&WS)[1]	197	1,042	31,504	1,206	33,949
State[2]	2,130	10,926	9,726	1,401	24,183
South Dakota[3]					
Federal (USF&WS)		1,144	981		2,125
State		1,047	979		2,026
Iowa[4]					
Federal (USF&WS)	1,000				1,000
State	384				384
TOTAL (State and Federal)	3,711	14,159	43,190	2,607	63,667
ALL MANAGED ACRES (WETLANDS AND UPLAND) FEDERAL AND STATE	10,851	45,799	144,118	7,747	208,515

[1]All wetland acres, regardless of size. From information provided by U.S. Fish & Wildlife Service, wetland acres average 39.86 percent of all acquired acres, and 24.17 percent of all easement acres on waterfowl production areas in Minnesota.
[2]All wetland acres, regardless of size. Wetland acres were calculated at 30 percent of all managed acres within the basin by the Minnesota Department of Natural Resources.
[3]All wetland acres, regardless of size. Wetland acres were calculated at 33 percent of all managed acres, based on information supplied by South Dakota.
[4]All wetland acres, regardless of size. Wetland acres are those provided from Iowa.

To analyze crop production potential, these land capability classes were grouped into twenty-five units called soil resource groups (SRG). Each SRG is an aggregation of soils which have similar cropping patterns and land treatments, and which require similar kinds of management for sustained crop production. Although some differences in physical characteristics may exist among soils in an SRG, they are expected to have similar crop yields and similar responses to fertilizer. Costs of production of a specific crop would be similar on soils in a SRG. Because a SRG is based on types of crops grown and productivity of the soil, more than one class or subclass may occur in one SRG.

Limitations and potentials of the soil classes are as follows:

Class I soils have few limitations on their use. They are deep, well-drained soils which are highly responsive to fertilizer and are suited to intensive cropping.

Class II soils have some limitations which reduce the choice of plants and require moderate conservation practices. The limitations, however, are few and the practices are easy to apply. Like Class I, these soils respond well to fertilizer and are very productive with proper management.

Class III soils have severe limitations which reduce the choice of plants and require special conservation practices. The limitations restrict the amount of cultivation, time of planting, kind of tillage, choice of crops, and harvesting.

Class IV soils have very severe limitations which restrict the choice of plants and require very careful management. Although these soils are cultivated, careful management is required and conservation practices are difficult to apply and maintain. Class IV soils may be well suited to only two or three of the more common crops, and production is generally low.

Soils in Classes V through VIII are generally not suited for cultivation and are mostly used for pasture, woodland, and wildlife food and cover areas. Class V land is nearly level but wet and subject to flooding and ponding hazards, which are impractical to remove. Class VI soils are such that it is practical to apply pasture improvements including seeding and fertilization. Such practices are generally considered impractical on Class VII soils. Soils in Class VIII have possible uses for wildlife, watershed protection, or recreation, but are unsuited for commercial production.

Table II-10 shows the present major land use by land capability class in the Minnesota River Basin. About 93 percent of the basin's land resources is in Class I through IV, and is generally suited for cultivation with practical land treatment. About three-fourths of the remaining land is in Class V and VII and suitable for grazing or forest with proper management. Only 1.3 percent of the basin's inventoried land had limitations precluding its use for commercial production.

Land in the basin is highly productive for agricultural crops. Seventy percent (70%) of the agricultural land is in the two most productive SRG's. The most prevalent SRG contains 3.7 million acres of deep, medium to moderately fine textured upland soils. Soils in this SRG are either capability Class I or II and require only limited land treatment. These soils are well suited for corn and soybean production and can be expected to sustain high yields with proper management. The second largest SRG contains 2.8 million acres of wet soils. When drained and properly managed, these soils are also excellent for crop production.

Twenty-three other SRG's are used to analyze production capabilities of the remaining 30 percent of the land. A much wider range of crops, crop yields, land treatment, and management practices are associated with these soils. Approximately 2.8 million acres are Class II, III, and IV, and are suitable for cultivation when adequately treated. Some of these soils have unique characteristics making them suited for production of various specialty crops, as well as the more common field crops. The remaining 700,000 acres are Class V through VIII, which have hazards limiting their use to pasture, forest, recreation, or wildlife cover and protection.

F. WATER RESOURCES

1. Runoff

In the Minnesota River Basin, the average annual runoff varies from nearly five inches in the southeast to less than one inch in the northwest (Figure II-7). The limiting season for water

TABLE II-10. LAND CAPABILITY CLASS BY MAJOR LAND USE, MINNESOTA RIVER BASIN

Class	Cropland		Pasture		Forest		Other		Total	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
I	967,601	11.8	17,181	2.0	7,691	2.4	46,702	7.8	1,039,175	10.4
II	5,384,083	65.5	281,227	32.2	90,770	28.2	224,319	37.2	5,980,399	59.7
III	1,540,683	18.8	233,050	26.7	28,985	9.0	140,414	23.3	1,943,132	19.4
IV	206,049	2.5	88,308	10.0	23,298	7.2	21,991	3.7	339,646	3.4
V	5,067	–	21,524	24.0	7,871	2.5	6,887	1.1	41,349	0.4
VI	86,787	1.1	137,129	15.7	70,685	22.0	36,319	6.0	330,920	3.3
VII	18,230	0.2	87,493	10.0	90,183	28.0	15,576	2.6	211,482	2.1
VIII	5,695	–	7,785	0.9	2,377	0.7	110,479	18.3	126,336	1.3
TOTAL	8,214,195	82.1	873,697	8.7	321,860	3.2	602,687	6.0	10,012,439	100.0

resource availability is in the late fall and winter. All the streams in the basin have periodic low flows.

On the Minnesota River, the highest annual peak discharges are most often the result of snowmelt runoff with an average of 30 and 40 percent of the floods occurring in March and April, respectively. May, June, July, and August account for the remaining 30 percent of the floods. The monthly distribution of floods is shown in Figure II-8. On the larger subbasin damage areas, 30 percent of the floods occur during the growing season (May through September).

2. Surface Water

More than three percent of the basin is lakes, wetlands, or streams. The basin includes 330 miles of main stem, 835 miles of major tributary streams, and 2,500 lakes. This represents approximately 25 percent of Minnesota's lakes, most of which are shallow with maximum depths of 15 feet. About one-third of the more shallow lakes have been affected by drainage. Water storage in the 2,500 lakes exceeds one million acre feet, or more than one inch of runoff from every acre in the basin. This storage is equivalent to 25 percent of the average annual runoff. Evapotranspiration from lake surfaces is high in the basin.

3. Groundwater

Groundwater in the basin is available from glacial sand, gravel aquifers, and sedimentary bedrock aquifers. Figure II-9, "Groundwater Distribution Map", illustrates the groundwater resources of the basin.

The solid blue area east of a line from Gaylord, New Ulm, and St. James, about one-third of the basin, has dependable supplies of good quality water from bedrock aquifers. In addition, glacial sands and gravels bordering the Minnesota River yield large supplies of water for wells. The remainder of the scattered blue areas on the map are glacial sand and gravel deposits that yield more than 500 gpm to wells. However, this water is very hard and very high in iron concentration, and, therefore, requires treatment. The green and yellow areas on the map yield undependable and poor quality water from the cretaceous bedrock. These glacial deposits generally yield less than 500 gpm to wells. The red areas consist of tight bedrock formations which yield little or no water, and the glacial deposits yield less than 40 gpm to wells.

The average thickness of the glacial till is 200 feet with a maximum thickness of more than 400 feet. The depth to the groundwater table is generally less than 100 feet. Surface outwash deposits yield as much as 1,000 gpm, but the average is closer to 500 gpm. Buried outwash deposits occur in the basin, but it is difficult to locate high yielding wells without considerable exploratory drilling.

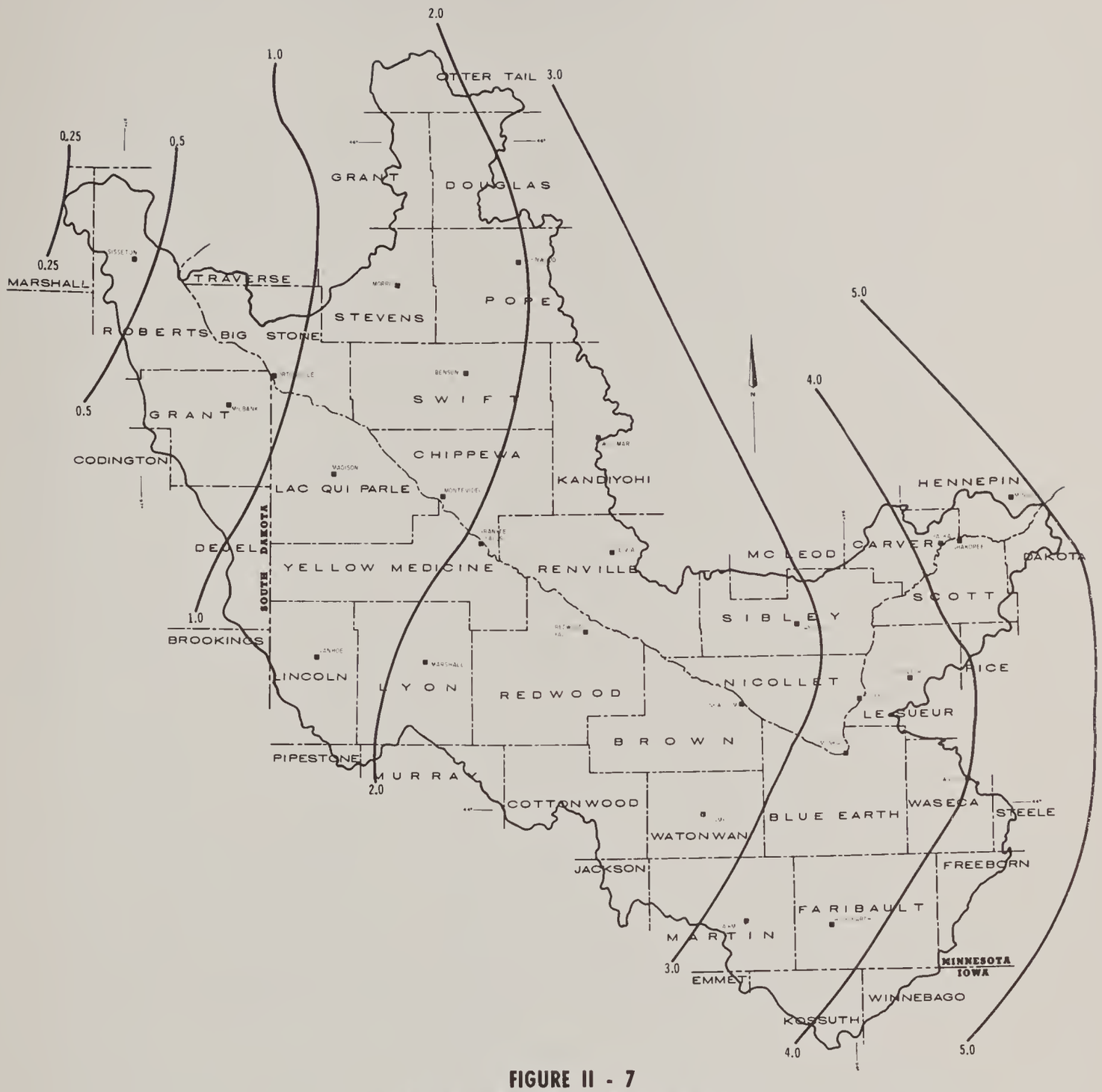
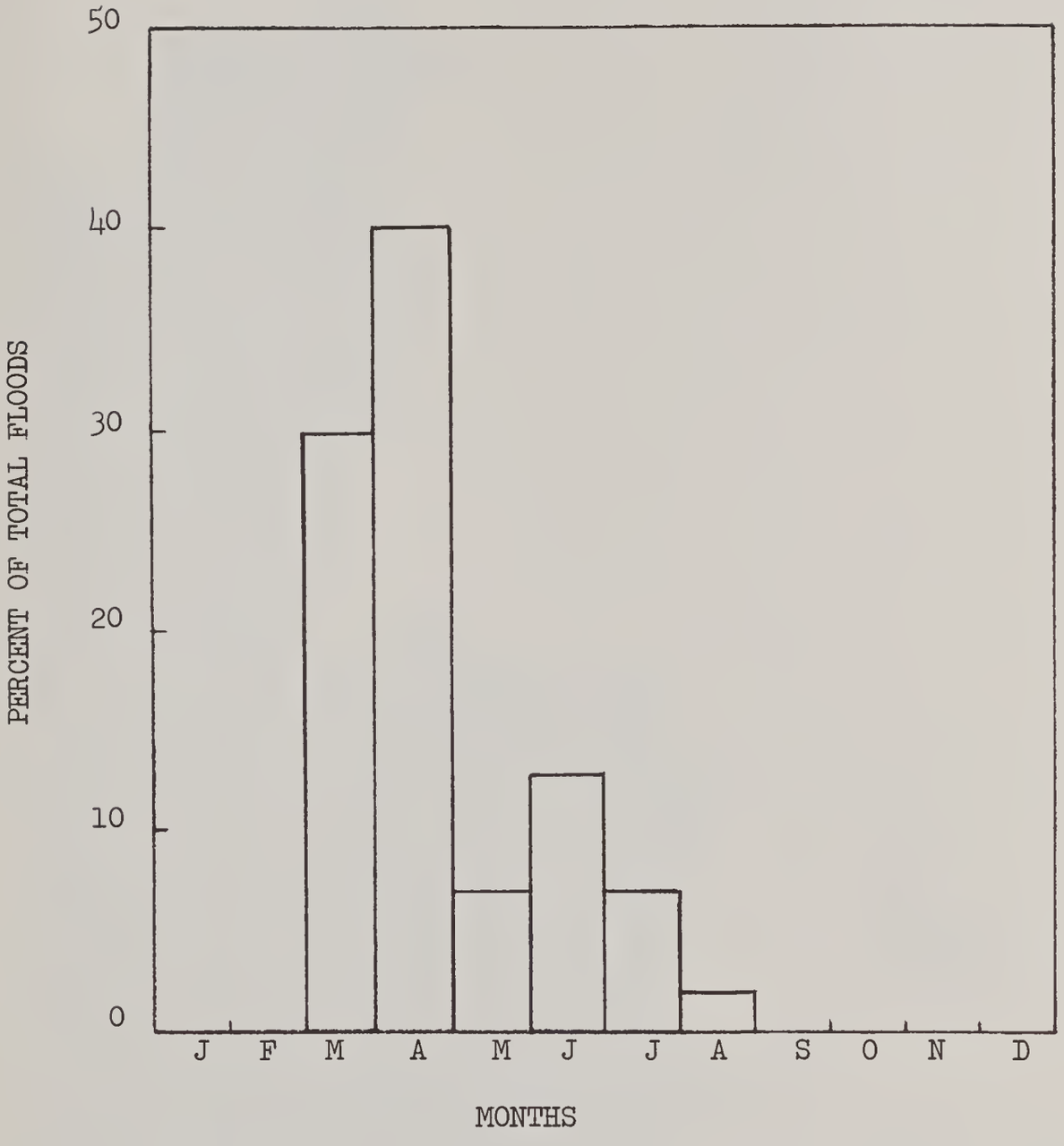


FIGURE II - 7
AVERAGE ANNUAL RUNOFF (INCHES)

SOA-SCS-LINCOLN, NEBR. 1976

Figure II - 8

TYPICAL MONTHLY FLOOD DISTRIBUTION ON
TRIBUTARIES TO THE MINNESOTA RIVER



U. S. DEPARTMENT OF AGRICULTURE

LEGEND

BEDROCK WATER SUPPLIES ARE LOW. GLACIAL DEPOSITS GENERALLY YIELD LESS THAN 40 GPM TO WELLS.

CRETACEOUS BEDROCK CONTAINS NONDEPENDABLE SUPPLIES OF POOR QUALITY WATER. GLACIAL DEPOSITS YIELD LESS THAN 40 GPM TO WELLS.

CRETACEOUS BEDROCK CONTAINS NONDEPENDABLE SUPPLIES OF POOR QUALITY WATER. GLACIAL DEPOSITS YIELD 40 TO 500 GPM TO WELLS.

AMPLE SUPPLY OF GOOD QUALITY WATER FROM BEDROCK AND/OR GLACIAL DEPOSITS.

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- COUNTY SEAT

SOURCE:
FAMILY OF MAPS 5,S-29,422 (7-15-71) AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION

SCALE 10 0 10 20 30 MILES
SCALE 1/1,000,000

GROUND WATER DISTRIBUTION MAP

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE II-9

I-16-76
5,0-35,537

USDA-SCS-LINCOLN, NEBR. 1976

The water from the glacial deposits is very hard, contains high iron concentration, and requires treatment for public water supply. Water samples from the northwestern portion of the basin range in hardness from 400 mg/l to more than 1,000 mg/l. Dissolved solids run up to 2000 mg/l, with iron up to 10 mg/l. There are large areas where the iron content of the well is 10 times the 0.3 mg/l maximum content recommended for drinking water.

The eastern one-third of the basin from just west of Mankato has high yielding, dependable bedrock aquifers. The remainder of the basin consists of tight granitic rocks that yield little water, or cretaceous sedimentary rocks that are generally highly mineralized and of very poor quality. Generally, water from the cretaceous rocks would not be used if adequate supplies of other water were available.

4. Available Data

The Office of Water Data Coordination, Department of the Interior, lists 24 United States Geological Survey (USGS) surface water data collecting gaging stations, and approximately 22 water quality collection locations in the basin. The surface water stations include both main and tributary stream sites in the Minnesota River.

Ten hydrologic atlases covering the basin have been published by the Department of Interior, USGS, in cooperation with the Minnesota Department of Natural Resources, Division of Waters. Data on quantitative yields, natural quality, use suitability, quantitative withdrawals, and consumption from ground and surface sources are contained in the atlases. The quantity and quality of both surface and groundwater in the majority of the basin is adequate for most uses (see Figure II-9).

The Minnesota Pollution Control Agency has published a Minnesota River Basin plan which divides the basin into segments and classifies the segments as to water quality. Approximately one-half the basin is classed as "effluent limited", and half as "water quality limited". The water quality limited area, unlike the effluent limited areas, will probably not meet relevant water quality standards, even after the application of the best feasible technology for industries and secondary treatment facilities for municipalities as defined in the 1972 Federal Water Pollution Control Act (FWPCA) amendments. More advanced treatment for municipalities and industries, as well as nonpoint source pollution control appears necessary.

Additional groundwater data is contained in the irrigation and the groundwater section of this report.

G. FISH, WATERFOWL, AND WILDLIFE

Fish and wildlife are a product of the environment, which provides a home for all of life. The use, misuse, or changes in use of this environment affects wildlife species composition, population density, and distribution.

Originally, most of the basin was a vast expanse of mid and tall grass prairie with extensive lake and wetland acres. Woodlands occurred along the rivers and streams and surrounded many of the lakes and wetlands. The predominant species of wildlife included buffalo, antelope, elk, deer, beaver, otter, mink, muskrats, various species of waterfowl and shorebirds, grouse, prairie chicken, squirrels, and rabbits.

The conversion of prairie and wetlands to agricultural uses has produced habitat conditions unlike those observed by early settlers. Nearly 85 percent of the land is now crop or pasture-land. Native prairie occurs only as small, isolated remnant patches. Forested acres along the rivers and tributaries, combined with woodlots, farmstead, and field windbreaks, total 322,000 acres, or 3 percent of the total land area. Less than 250,000 acres of wetlands remain. This shift in land uses has eliminated buffalo, antelope, and elk from the basin, and species more adaptable to farmland habitat now reside.

Figure II-10 presents a zonation of the basin by major farming practice and dominant wildlife species. This is used by the Minnesota Department of Natural Resources[1] for management purposes. Distributions, and relative concentrations of the wildlife species which provide hunting or trapping opportunities, or which have reasonable potential to do so, are displayed in Figures II-11. An indication of population trends and numbers for pheasants, hungarian partridge, cottontails, jackrabbits, and mourning doves is provided in Figure II-12 and Table II-11. Whitetailed deer and duck harvest data is contained in Tables II-12 and II-13. Between 1960 and 1974, the roadside counts of partridge and mourning dove have, in general, increased while cottontail and jackrabbit counts have decreased. The highest deer population and harvest are in Study Area III where the harvest is nearly twice the rate of other study areas. Duck harvest per square mile is highest in Study Areas III and IV. In 1970 an estimated 23.6 ducks per square mile were harvested basin-wide.

Habitat quantity and quality are the major factors which control populations. When either is inadequate – disease, starvation, predation, and winter take larger numbers of individuals; successful reproduction declines; and total populations drop to the carrying capacity of the available habitat. Adequate food and cover is especially critical during winter, and during reproduction and rearing periods.

Whitetailed deer habitat is primarily restricted to the wooded river bottoms and lands associated with them. Farmlands provide abundant food and thus, winter starvation losses are minimal. The quantity and distribution of forest and brush cover are the limiting factors. The highest deer concentrations occur where croplands are marginal and dissected by windbreaks, woodlots, or forest and brush areas among the fields. Very high localized densities are attained with this increased fringe effect, as reflected by the distribution map and harvest data for Study Areas III and IV. However, most of the forests are mature stands and moderately to heavily grazed, leaving little or no undergrowth and ground vegetation. This produces only fair quality habitat.

Upland game bird and mammal populations have steadily declined since their peaks in the middle 1950's. Intensified agriculture has shifted from crop rotation systems, which included small grain and hay, to continuous row cropping on more acres each year. Harvest efficiency has increased, leaving little waste for winter food. Considerable natural cover has been converted in the process. Due primarily to the resulting shortage of winter food and cover, and the inadequate distribution of nesting habitat, the ring-necked pheasant breeding population is only about 15 percent of previous levels. Cottontails and jackrabbits have shown similar declines. The Hungarian partridge was never as abundant as the pheasant. The downward trend of Hungarian partridge appears to have been halted and counts have increased in recent years. The mourning dove, a migratory upland bird, inhabits the basin when food is abundant and conditions are ideal. Its numbers have increased and the species appears to be doing well. Doves are presently protected from hunting, but show good potential to supply hunting opportunities.

Excellent habitat is provided on approximately 142,000 upland acres which are included within state and federal management areas, generally in association with wetlands. Windbreaks, roadside ditches, and scattered natural areas provide the remaining upland habitat.

[1] From unpublished Minnesota Department of Natural Resources Management Report "Organization and Planning Manual for Farmland Wildlife Research Unit". Farmland Wildlife Populations and Research Unit, Alfred Berner, et. al., Madelia, MN. Species maps were abstracted from statewide maps and incorporate information supplied by South Dakota and Iowa where possible.

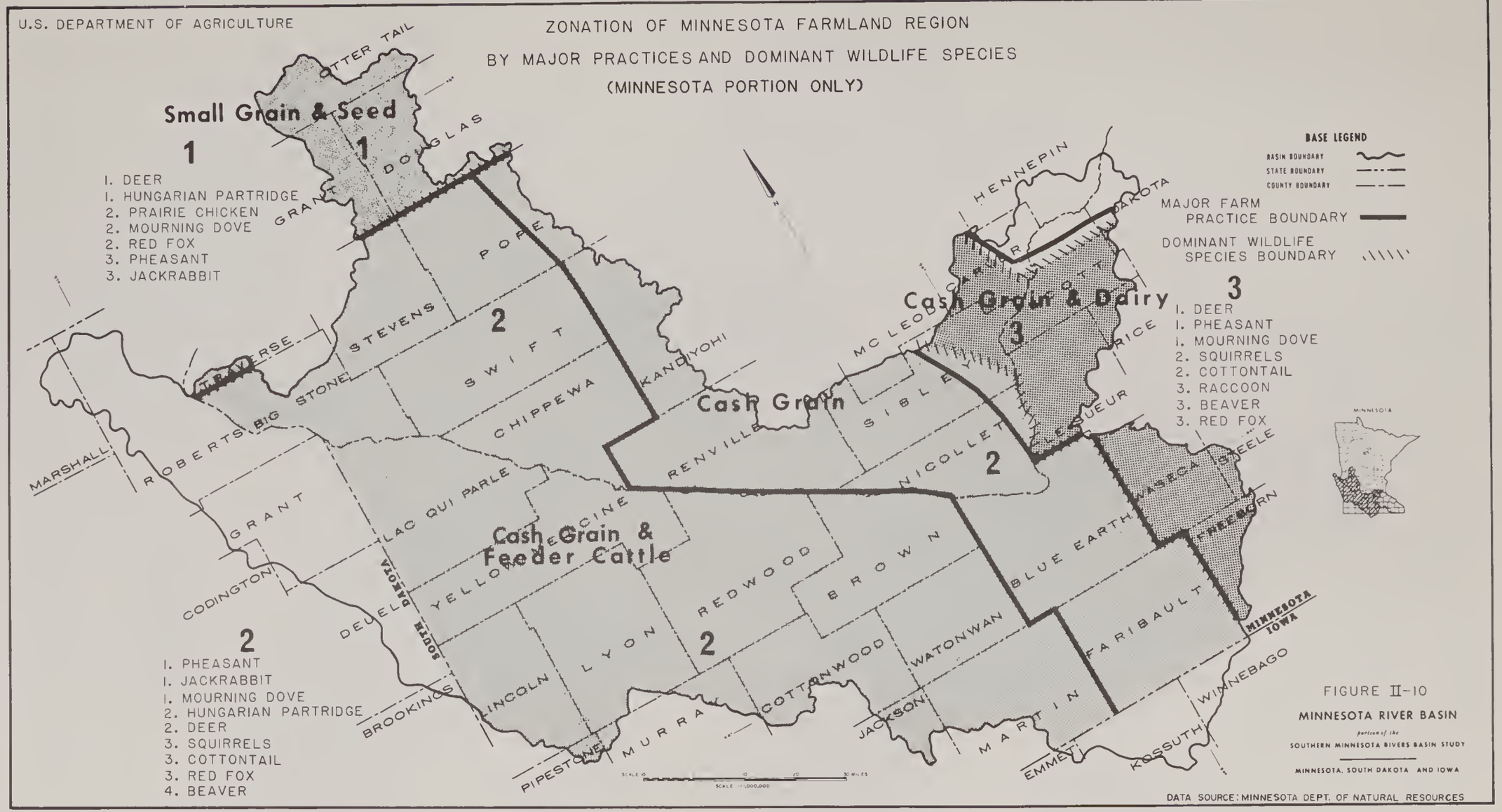

U.S. DEPARTMENT OF AGRICULTURE
ZONATION OF MINNESOTA FARMLAND REGION
BY MAJOR PRACTICES AND DOMINANT WILDLIFE SPECIES
(MINNESOTA PORTION ONLY)
Small Grain & Seed
1
1. DEER
1. HUNGARIAN PARTRIDGE
2. PRAIRIE CHICKEN
2. MOURNING DOVE
2. RED FOX
3. PHEASANT
3. JACKRABBIT
Cash Grain & Dairy
3
1. DEER
1. PHEASANT
1. MOURNING DOVE
2. SQUIRRELS
2. COTTONTAIL
3. RACCOON
3. BEAVER
3. RED FOX
Cash Grain
2
Cash Grain & Feeder Cattle
2
1. PHEASANT
1. JACKRABBIT
1. MOURNING DOVE
2. HUNGARIAN PARTRIDGE
2. DEER
3. SQUIRRELS
3. COTTONTAIL
3. RED FOX
4. BEAVER
BASE LEGEND
BASIN BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
MAJOR FARM PRACTICE BOUNDARY
DOMINANT WILDLIFE SPECIES BOUNDARY
OTTER TAIL
GRANT
DOUGLAS
POPE
STEVENS
TRAVERSE
BIG STONE
SWIFT
CHIPPEWA
KANDIYOHI
MARSHALL
ROBERTS
GRANT
LAC QUI PARLE
YELLOW MEDICINE
CODINGTON
DEUEL
SOUTH DAKOTA
BROOKINGS
LINCOLN
LYON
REDWOOD
BROWN
RENVILLE
SIBLEY
NICOLLET
LE SUEUR
MC LEOD
HENNEPIN
CARVER
SCOTT
DAKOTA
RICE
WASECA
STEELE
BLUE EARTH
FREEBORN
MINNESOTA
IOWA
FARIBAULT
MARTIN
WATONWAN
COTTONWOOD
JACKSON
EMMET
KOSSUTH
WINNEBAGO
PIPESTONE
MURRAY
MINNESOTA
FIGURE II-10
MINNESOTA RIVER BASIN
portion of the
SOUTHERN MINNESOTA RIVERS BASIN STUDY
MINNESOTA, SOUTH DAKOTA AND IOWA
DATA SOURCE: MINNESOTA DEPT. OF NATURAL RESOURCES

FIGURE II-11

MINNESOTA RIVER BASIN FARMLAND GAME

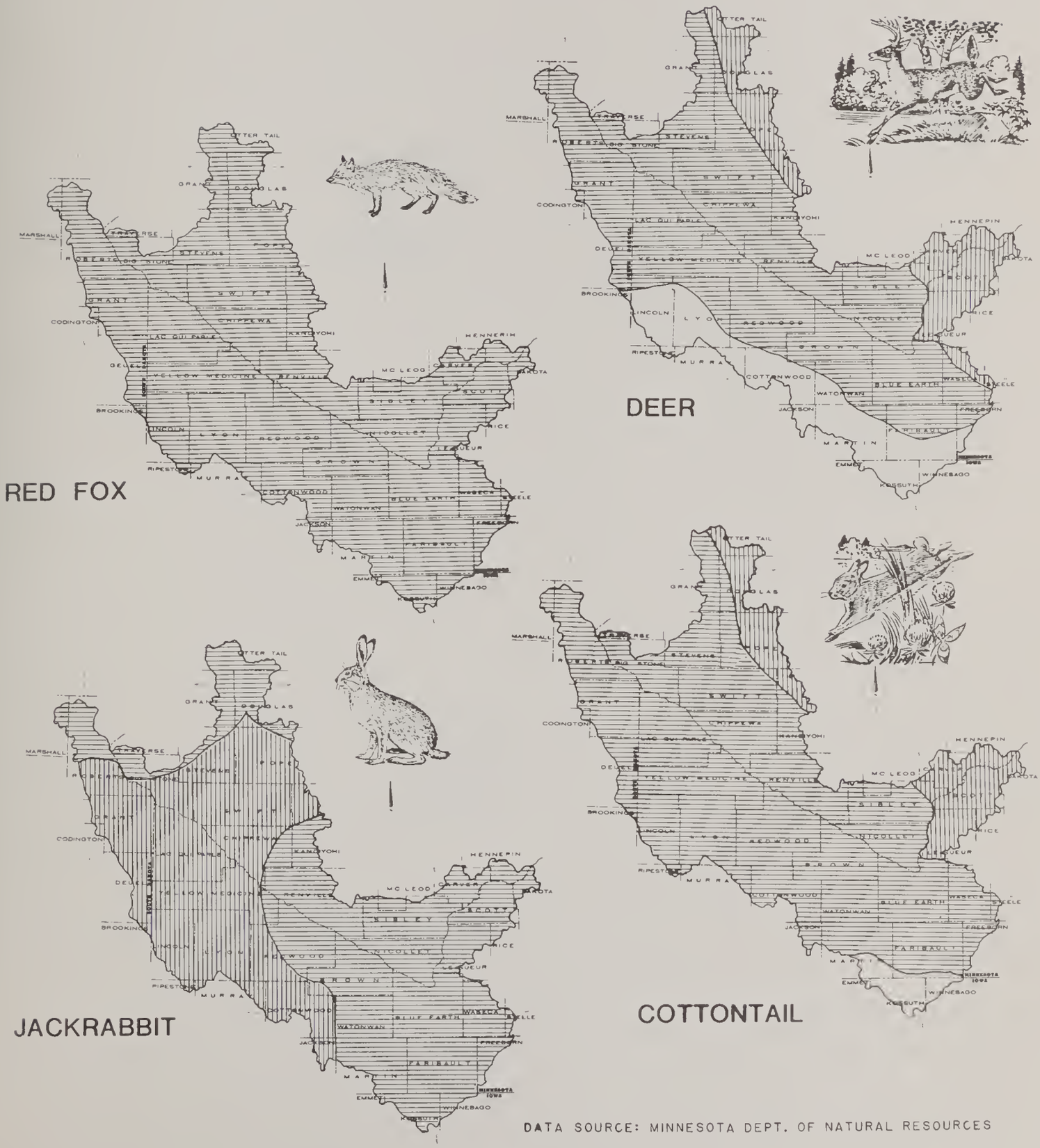
DISTRIBUTION AND RELATIVE DENSITY

CONCENTRATION

HIGHEST

MEDIUM

LOW



DATA SOURCE: MINNESOTA DEPT. OF NATURAL RESOURCES

FIGURE II-11

MINNESOTA RIVER BASIN FARMLAND GAME

DISTRIBUTION AND RELATIVE DENSITY

CONCENTRATION

- HIGHEST
- MEDIUM
- LOW

DATA SOURCE : MINNESOTA DEPT. OF NATURAL RESOURCES

FIGURE II-11

MINNESOTA RIVER BASIN FARMLAND GAME

DISTRIBUTION AND RELATIVE DENSITY

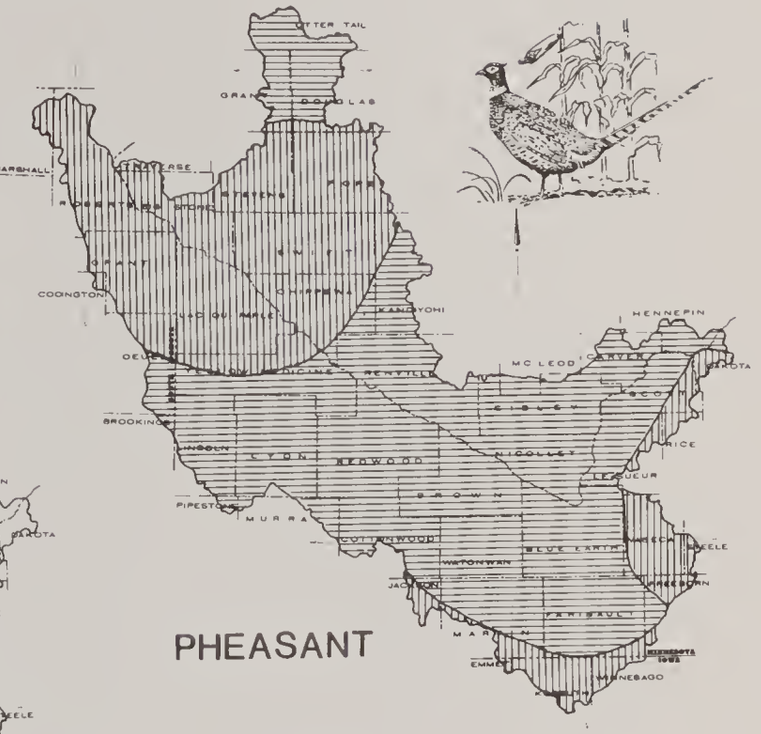
CONCENTRATION

HIGHEST

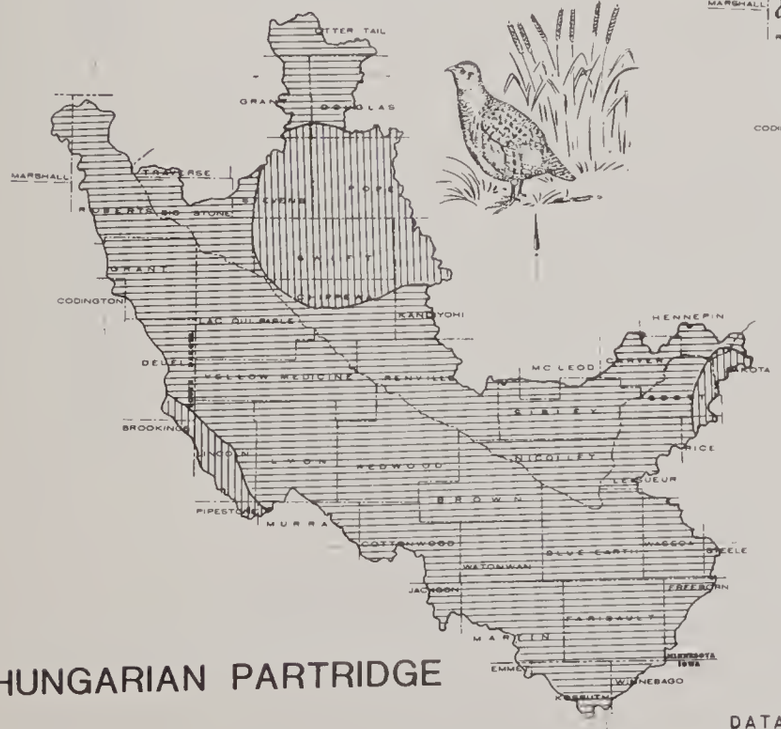
MEDIUM

LOW

PRAIRIE CHICKEN



PHEASANT



HUNGARIAN PARTRIDGE

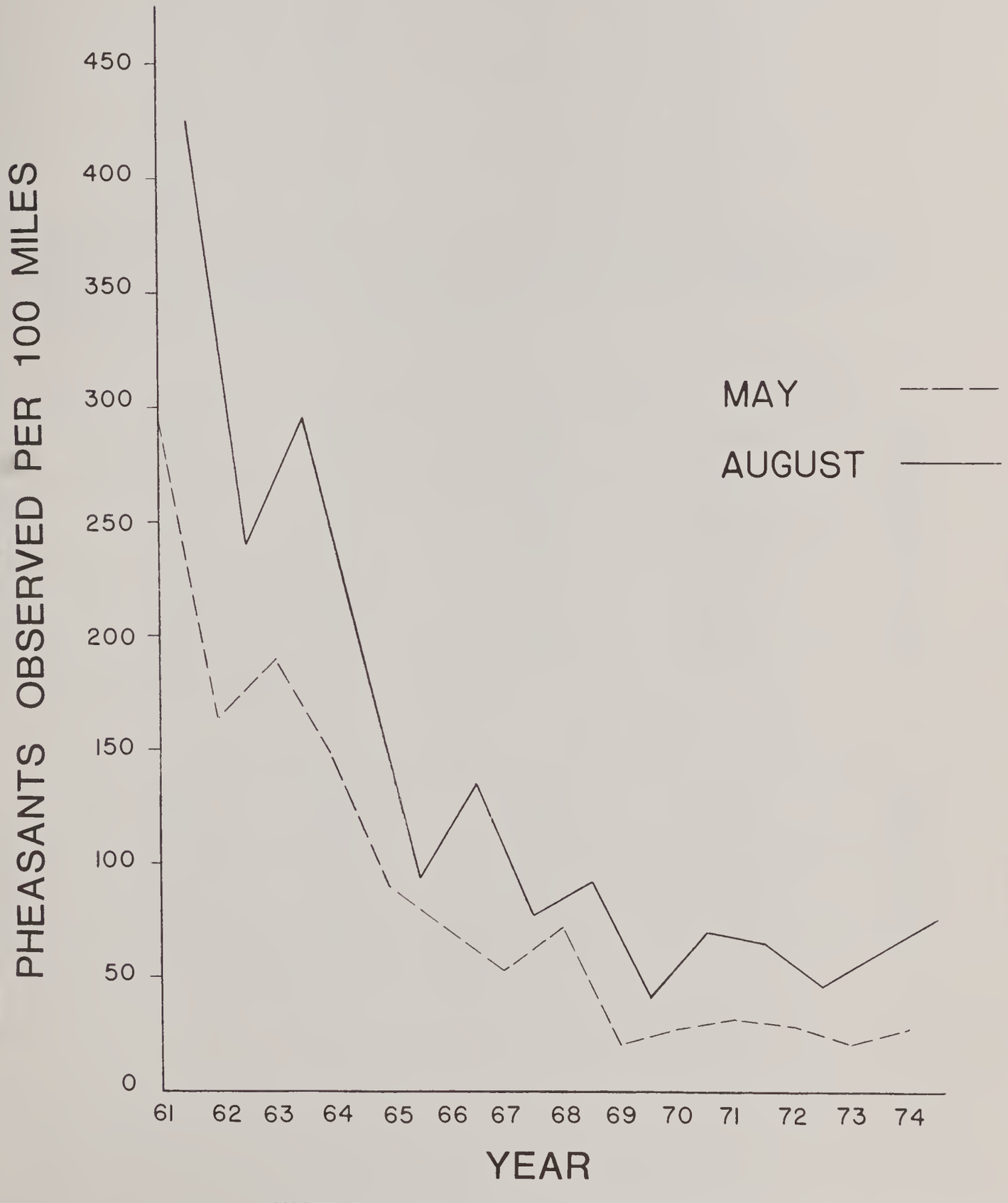
MOURNING DOVE

DATA SOURCE: MINNESOTA DEPT. OF NATURAL RESOURCES

FIGURE II-12

SUMMARY OF ROADSIDE PHEASANT CENSUS FOR MINNESOTA RIVER BASIN

1961-1974



MINNESOTA DEPARTMENT OF NATURAL RESOURCES PROJECT QUARTERLYS.

TABLE II-11. NUMBER OF HUNGARIAN PARTRIDGE, COTTONTAIL RABBITS, JACKRABBITS, AND MOURNING DOVES PER 100 MILES ON THE AUGUST ROADSIDE COUNTS (1960-1974). ALSO, DEER PER 100 MILES FOR 1974[1]

	Per 100 Miles				
Year	Hungarian Partridge	Cottontails	Jackrabbits	Mourning Doves	Whitetailed Deer
1960	4.7	10.0	3.5	293	–
1961	4.6	9.6	3.3	368	–
1962	5.6	9.7	2.7	321	–
1963	5.0	7.8	2.4	349	–
1964	1.7	6.2	2.0	374	–
1965	3.5	4.6	1.7	272	–
1966	4.0	5.8	1.9	295	–
1967	5.0	6.0	3.0	NC	–
1968	3.6	5.9	2.0	281	–
1969	3.6	5.3	2.9	233	–
1970	9.4	5.0	2.0	341	–
1971	11.3	4.0	2.3	414	–
1972	7.0	3.9	2.0	333	–
1973	19.4	6.0	2.1	407	–
1974	12.4	6.3	1.5	382	0.9[2]

[1]Reprinted from Minnesota Department of Natural Resources Wildlife Research Quarterly, Volume 34, No. 3, page 132. Averages are those for the 64 counties in the southern half of Minnesota which are surveyed each year. The 37 Minnesota River Basin counties fall within this area and would follow these averages closely.
[2]Deer were included in the roadside count for the first time in 1974.

TABLE II-12. DEER HARVEST PER SQUARE MILE, MINNESOTA RIVER BASIN[1]

Year	Study Area I	Study Area II	Study Area III	Study Area IV	Basin Totals
1967	0.29	0.4	0.48	0.29	0.37
1968	0.20	0.27	0.41	0.25	0.28
1969	0.24	0.24	0.36	0.29	0.28
1970	0.22	0.40	0.50	0.24	0.34
1971	Season Closed Statewide				
1972	0.22	0.31	0.52	0.31	0.34
1973	0.29	0.44	0.66	0.37	0.44
1974	0.23	0.25	0.83	0.41	0.43

[1]From Minnesota Department of Natural Resources Project Quarterlys.

TABLE II-13. DUCK HARVEST PER SQUARE MILE, MINNESOTA RIVER BASIN[1]

Year	Study Area I	Study Area II	Study Area III	Study Area IV	Study Totals
1967	13.40	10.92	35.00	28.60	21.98
1968	11.29	7.72	16.78	17.64	13.36
1969	14.76	11.52	30.43	25.57	20.57
1970	17.85	13.27	33.82	29.74	23.67

[1]From Minnesota Department of Natural Resources Project Quarterlys.

The Minnesota River Basin contains a significant number of wetlands (see Tables II-8 and II-9). Combined with those of surrounding states and Canada, they comprise the major waterfowl production area for the entire midsection of the United States. The most common game species of waterfowl include mallard, blue and green winged teal, ring-necked duck, wood duck, canada goose, and snow goose. Numerous other species of waterfowl and shorebirds are found throughout the basin. Wetland and associated nesting and brooding habitat is but a fraction of former acreages. Croplands have long provided adequate food supplies. The major impact from agriculture has been wetland drainage. Duck harvests have gradually increased due primarily to increased hunting days per season per hunter.

Some species have not been able to adjust to environmental change. Species considered rare or endangered that may be seen in the basin include the bald eagle, golden eagle, greater sandhill crane, pileated woodpecker, american osprey, american peregrine falcon, and the whooping crane. The status of these and other species is periodically reviewed and updated by the state wildlife agencies and the U.S. Fish and Wildlife Service.

Fish lakes total 160,000 acres (see Table II-14). Many of these are shallow, fertile, and classified as rough fish lakes. Fifty-seven percent of the basin's lake acres occur in Study Area III, including 65 percent of all the lakes classified as game fish lakes.

Lake game fish include northern pike, largemouth bass, walleye, crappie, and sunfish. Of the total annual catch by weight, about 30 percent are northern pike and about 20 percent are crappie and sunfish. Bullheads are well suited for over winter survival in shallow waters. Although considered a rough fish in many areas, bullheads account for about 25 percent of the total harvest by weight each year. The fishing lakes within the Minnesota River Basin are highly productive, averaging 40 pounds of fish harvested per acre each year.

Rivers and streams provide 2,000 miles of riverine habitat throughout the basin. Portions of 13 streams provide cold water fisheries,* but the majority of rivers and streams provide marginal warm water habitat and sustain mostly rough fish populations. Brown trout and brook trout occur in the few remaining cold water reaches. Smallmouth bass, rock bass, crappies, and some channel catfish inhabit the better warm water streams. Carp and other rough fish have invaded most of the streams and many of the lakes.

Quality of fish habitat has decreased with increases of erosion, siltation, and accelerated eutrophication of water bodies by nutrient rich runoff from agricultural lands. Urban and industrial pollution is also a growing contributor to the degradation process.

TABLE II-14. FISH LAKES AND MARGINAL FISH LAKES (10 ACRES OR LARGER)[1]

	Area I	Area II	Area III	Area IV	Basin-Wide
Fish Lakes and Acres	17 (5,221)	7 (7,109)	61 (51,856)	54 (15,278)	139 (79,464)
Marginal Lakes and Acres	35 (12,252)	42 (13,829)	205 (37,810)	83 (14,952)	365 (78,843)
TOTAL	52 (17,473)	49 (20,938)	266 (89,666)	137 (30,230)	504 (158,307)

[1]Minnesota Department of Natural Resources Lake Inventory Classifications.

*Designated as trout streams by the State of Minnesota, Department of Natural Resources, Commissioner's Order No. 1852.

In addition to providing hunting, trapping, or fishing opportunities, fish and wildlife resources provide opportunities for nature study, photography, and aesthetic appreciation. Predators, rodents, songbirds, raptors, amphibians, and insects all affect nature's balance and man's environment.

H. RECREATION RESOURCES

Outdoor recreation opportunities within the basin are many and varied. Study Area III, which has most of the lakes, provides the largest share of facilities for waterbased activities. Recreation trails, golf courses, tennis courts, picnic grounds, and swimming pools are most numerous in Study Area IV, which is closest to the urban population. Table II-15 lists the basin's recreation facilities by activity and study area. This inventory combines data from the Minnesota Department of Natural Resources 1974 State Comprehensive Outdoor Recreation Plan (SCORP) with the recently completed inventory of private facilities by the National Association of Conservation Districts.

The estimated current levels of participation in outdoor recreation activities in the basin are presented in Table II-16. Annual visitations are converted to weekend (peak) day occasions to provide a better analysis of facility capacities. Most facilities are not adequate to meet the present demand when acceptable space standards are applied. Table II-17 converts the data in Table II-16 to resources needed to supply current levels of participation, without overuse of the facilities. Specific deficiencies, problems, and needs are discussed in Chapter IV.

I. ARCHEOLOGICAL AND HISTORICAL RESOURCES

In a historical sense, the very heart of Minnesota lies in the river valley which gave the state its name. Since glacial times, this valley has witnessed man's struggle to survive and control his surroundings. About ten thousand years ago, primitive hunters camped on the edge of melting sheets of ice in pursuit of the mammoth and giant bison. Brown's Valley Man left his bones and weapons to be found by later inhabitants. Over a period of thousands of years more sophisticated cultures gradually developed in this central river valley. The ancestors of the modern Indian built permanent villages, raised crops, hunted, fought, and built mounds for their dead along its bluffs. The dawn of recorded history found the Dakota or Sioux Indians well established on the borders of this beautiful river.

Among the more significant prehistoric sites in the basin are:

Brown's Valley Man – (5,000-6,000B.C.), Brown's Valley, Traverse County.

Pederson Site – (c. 1,000 B.D.-1600 A.D.), Lake Benton, Lincoln County.

Pipestone National Monument[1] – (prehistoric to present), Pipestone County.

Fox Lake – (500 A.D.), near Sherburne, Martin County.

Mountain Lake – (c. 1,000 B.C.-1600 A.D.), Cottonwood County.

Jeffers Petroglyphs – (3,000 B.C.-1700 A.D.), Cottonwood County.

Vosburg-Humphrey – (1300 A.D.), near Winnebago, Faribault County.

Cambria – (1200 A.D.), Blue Earth County.

Concentrations of prehistoric sites are in the Big Stone Lake area, the Blue Earth River drainage, and along the Lower Minnesota River from Henderson downstream to the river's mouth.

[1]Slightly outside the basin's boundary.

TABLE II-15. SUMMARY OF OUTDOOR RECREATION FACILITIES, PUBLIC AND PRIVATE – 1975, MINNESOTA RIVER BASIN*

Facility	Area I	Area II	Area III	Area IV	Basin TOTALS
Number of Resorts	6	4	89	14	113
Resort Family Units (No.)	31	51	546	64	692
Campgrounds (No.)	22	17	63	20	122
Walkin and Drivein Campsites (No.)	818	488	1,014	379	2,699
Camping Acres	37.8	63.1	107.6	57.0	265.5
Golf Courses (No.)	12	14	6	32	64
Golf Holes	135	144	54	439	772
Golf Acres	966	1,010	338	2,587	4,901
Athletic Fields (No.)	81	73	66	290	510
Tennis Courts (No.)	65	49	41	224	379
Athletic Activity Acres	507	295	304	1,852	2,958
Picnic Tables (No.)	935	855	1,211	2,053	5,054
Picnic Ground Acres	39.9	42.5	67.0	174.8	324.2
Water Accesses (No.)	53	49	118	94	314
Access Parking Spaces	417	202	935	1,526	3,080
Access Acres	20.3	10.4	35.3	50.5	116.5
Rental Boats (No.)	71	36	849	264	1,220
Swimming Beaches (No.)	15	15	86	39	155
Beach Shoreline (Lin. ft.)	3,139	5,116	19,056	10,446	37,757
Swimming Beach Water Acres	9.2	12.4	29.1	23.1	73.8
Swimming Beach Land Acres	4.4	3.9	40.3	25.8	74.4
Swimming Pools (No.)	7	11	6	16	40
Pool Surface Acres ($ft.^2$)	28,389	63,881	20,692	82,159	195,121
Recreation Trails (Total Mi.)[1]	20	45	66	235	366
Nature Trails (Mi.)	0.5	13	10	24.7	48.2
Horseback Trails (Mi.)	9	34	25	45	113
Snowmobile Trails (Mi.)	10	36	41	66	153
Hiking Trails (Mi.)	17	41	44	130	232
Bicycle Trails (Mi.)	11	1	14	43	69
Multi-purpose Trails (Mi.)	13	36	33	147	229
Fair Grounds (No.)	1	2	3	3	9
Race Tracks (No.)	2	2	1	4	9
Highway Rest Areas (No.)	15	15	11	29	70
Ski Areas (No.)	1	–	–	4	5
Shooting Ranges and Hunting Preserves	6	11	9	18	44
Riding Stables (No.)	1	–	–	19	20
Public Hunting Acres[2]	10,852	45,799	140,611	7,747	205,009
Upland Acres	7,141	31,640	98,545	5,140	142,466
Wetland Acres	3,711	14,159	42,066	2,607	62,543
Fishing Lakes (No.)	52	49	266	137	504
Fishing Lake Acres	17,473	20,938	89,666	30,230	158,307
Total Recreation Water Acres	35,988	36,143	134,980	67,170	274,291
Total Recreation Land Boundary Acres	14,480	54,549	146,990	40,665	256,684

[1]Multiple use on some trails makes individual use mileages non-additive to these totals.
[2]All acres are within state or federal wildlife management areas as listed in Table II-9, except for 3,506 acres of Federal Waterfowl Production Areas which are specifically closed to hunting.

*Condensed from computer printout of individual facilities supplied by MDNR Special Program – Strata No. 203. All Facilities and Minnesota portion only accept Public Hunting Acres, Fishing Lakes and Acres, and Total Recreation Land and Water Acres which include South Dakota and Iowa inputs.

TABLE II-16. ESTIMATED ACTIVITY OCCASIONS OCCURRING ON AN AVERAGE WEEKEND DAY – 1975, MINNESOTA RIVER BASIN

Activity	Study Area I	Study Area II	Study Area III	Study Area IV	Basin TOTALS
Swimming	43,858	39,598	25,612	50,500	159,568
Playing Golf	4,875	4,401	2,847	5,613	17,736
Playing Tennis	3,209	2,898	1,874	3,695	11,676
Playing Outdoor Games	75,502	68,169	44,092	86,937	274,700
Walking for Pleasure	12,516	11,301	7,309	14,412	45,538
Bicycling	55,598	50,198	32,468	64,018	138,264
Horseback Riding	4,054	3,660	2,367	4,668	14,749
Trap and Target Shooting	1,233	1,113	720	1,420	4,486
Fishing	9,427	9,741	7,060	12,572	38,800
Boating	3,438	3,552	2,575	4,585	14,150
Canoeing	1,910	1,973	1,430	2,547	7,860
Water Skiing	8,733	9,024	6,540	11,647	35,944
Sailing	555	574	416	741	2,286
Camping	7,633	7,887	5,716	10,179	31,415
Hiking	818	845	612	1,091	3,366
Picnicking	13,222	13,633	9,902	17,633	54,420
Nature Walks	16,043	16,577	12,015	21,395	66,030
Snowmobiling	14,038	14,506	10,513	18,722	57,779
Snow Skiing	653	675	489	871	2,688
Small Game Hunting	5,263	5,232	4,477	6,730	21,702
Large Game Hunting	9,963	10,273	7,433	13,256	40,925
Waterfowl Hunting	3,439	3,495	2,502	4,505	13,941

Written records of the Minnesota River Basin extend back to 1700 A.D. when Pierre Le Sueur, a French trader and explorer, built a fort called L'Hillier on the Blue Earth River near modern Mankato. Jonathan Carver, a New Englander, wintered on the St. Peter's River near modern Carver in 1967. During the American Revolution, Peter Pond, a Yankee trader, canoed up this river to trade with the Sioux tribe. In 1805, Lieutenant Zebulon Pike bought the land at the junction of the St. Peter's and Mississippi Rivers as a site for a military post. In 1820, U.S. troops began to build a stone fort on the bluff overlooking these rivers.

For the next thirty years, the valley of the St. Peter's River remained the home of many bands of Sioux Indians, of the fur traders, and their descendants. Fort Renville, a fur post, was operated at the widening of the river called Lac qui Parle from about 1826-1845. Nearby was built the Lac qui Parle Mission which sought to educate and Christianize the Sioux. Later, missions were built downstream at Hazelwood and Traverse des Sioux. Hundreds of the creaking wooden Red River carts laden with buffalo hides from remote Pembina, on the Canadian border, put deep ruts in the river bottoms and made the Red River Trails which terminated at St. Paul from 1847-1862.

The treaties of Traverse des Sioux and Mendota were signed in 1851. By their terms, the resident Sioux Indians ceded millions of acres of rich land between the Mississippi and Big Sioux Rivers to the white man. These documents restricted the Indians to a narrow reservation on the upper Minnesota River and opened the land to white settlers. Fort Ridgely was later built on the river, near Fairfax in Nicollet County, as were the Lower and Upper Sioux Agencies near Morton, and Granite Falls. These locations were centers where efforts were made to teach the ways of the white men to the Indians. Nearby was erected the elaborate stone "castle" of Joseph R. Brown, a noted frontiersman and public figure.

Hemmed in by white men, the Sioux began their uprising of August 1862. It led to two pitched battles at New Ulm and to two vital battles at Fort Ridgely for control of the Minnesota River Valley. An early portion of this tragic event began with an ambush at the Redwood Ferry below the Lower Sioux Agency. The end came with the battles of Birch Coulee and

TABLE II-17. RESOURCES NECESSARY TO PROVIDE 1975 RECREATION ACTIVITY LEVELS WITH ACCEPTABLE SPACE STANDARDS*, MINNESOTA RIVER BASIN

Activity	Area I	Area II	Area III	Area IV	Basin TOTALS
Swimming Beach					
Water (Acres)	14.8	13.4	8.7	17.1	54.0
Land (Acres)	74.1	66.9	43.3	85.3	269.6
Pools (1000 ft.^{2})	493.4	445.5	288.1	568.1	1,795.1
Golfing					
Rounded to Even (Holes)	153	144	90	180	567
9 Hole Course (Acres)	1,530	1,440	700	1,800	5,610
Tennis (Courts)	100	91	59	116	366
Outdoor Game Fields (Acres)	866.6	782.5	506.1	997.9	3,153.1
Trap and Target Shooting (Acres)	616.5	556.5	360.0	710.0	2,243
Fishing – Water (Acres)	21,211	21,917	15,885	28,287	87,300
Boating – Water (Acres)	4,584	4,736	3,433	6,113	18,866
Canoeing – Stream (Miles)	119.4	123.3	89.4	159.2	491.3
Water Skiing – Water (Acres)	21,833	22,560	16,350	29,118	89,861
Sailing – Water (Acres)	740	767	555	988	3,050
Camping					
Sites	1,908	1,972	1,429	2,545	7,854
Acres (Developed)	381.7	394.4	285.8	509.0	1,570.0
Acres (Support)	1,908	1,972	1,429	2,545	7,854
Hiking Trails (Miles)	16.4	16.9	12.2	21.8	67.3
Picnicking					
Tables	2,204	2,272	1,650	2,939	9,065
Acres (Developed)	440.7	454.4	330.1	587.8	1,813
Acres (Support)	2,204	2,272	1,650	2,939	9,065
Nature Trails (Miles)	320.9	331.5	240.3	427.9	1,320.6
Snowmobile Trails (Miles)	467.9	483.5	350.4	624.1	1,925.9
Snow Skiing (Acres)	16.3	16.9	12.2	21.8	67.2
Hunting Small Game (Upland Acres)	42,104	41,856	35,816	53,840	173,616
Hunting Large Game (Upland Acres)	637,632	657,472	475,712	848,384	2,619,200
Hunting Waterfowl (Wetland Acres)	15,476	15,728	11,259	20,273	62,736

*Standards are not available for bicycling, horseback riding, or walking for pleasure. Acres for large game hunting are based on a two day season, which has been established in the MRB area in recent years.

Wood Lake. A total of 269 captives were released at Camp Release near modern Montevideo. Then the military Camp Pope was established near Wood Lake and used as a base for military expeditions into Dakota territory in pursuit of the fleeing Sioux tribesmen.

With the close of the Sioux and Civil Wars, settlers changed the valley into farmland. Railroads replaced steamboats as the mode of transportation and the frontier was supplanted by farms, villages, and towns.

Many of the prehistoric sites in the basin are on the National Register of Historical Places. In addition, the following Historic Districts are listed in the National Register:

Fort Snelling Historic District: (Dakota, Ramsey and Hennepin Counties)
Camp Coldwater
Cantonment New Hope
Major Lawrence Taliaferro's Indian Agency

Lac qui Parle Mission and Village Historic District: Chippewa and Lac qui Parle Counties)

Upper Sioux Agency Historic District: (Yellow Medicine County)

Lower Sioux Agency Historic District: (Redwood County)

Shakopee Historic District: (Scott County)
Pond Mill Site
Shakopee's Village
Prehistoric Mounds

Ottawa Village Historic District: (Le Sueur County)

Lake Benton Historic District: (Chippewa County)

Table II-18 lists the archaeological and historical sites located in the basin.

J. UNIQUE AND SCENIC AREAS

Certain areas and sites within the basin exhibit unique characteristics, and, whether natural or historic, they provide residents and visitors alike a special kind of aesthetic experience or insight into the region's past. There are 192 unique natural and scenic sites which have been inventoried within the basin (see Table II-19).

TABLE II-18. ARCHEOLOGICAL AND HISTORICAL SITES SUMMARY BY STUDY AREA, MINNESOTA RIVER BASIN

Study Area	Area I	Area II	Area III	Area IV	Total Basin
Archaeological Sites					
Mounds and Burial Sites	16	56	62	118	252
Habitations and Villages	30	28	14	17	89
Other[1]	1	6	6	4	17
TOTAL	47	90	82	139	358
Historical Sites					
Forts and Missions	6	22	10	7	56
Historic Houses	6	6	1	6	19
Indian Conflicts	0	3	0	3	6
Other[2]	2	27	21	14	64
TOTAL	14	58	32	30	134
TOTAL SITES	61	148	114	169	492

[1]Includes sites of bison kills, petroglyphs, rock alignments, dance rings, and undetermined status.
[2]Includes sites of geology markers, historic trails, ethnic settlements, folklore markers, historical districts, and architectural sites not included in HISTORIC HOUSES category.

TABLE II-19. UNIQUE NATURAL AND SCENIC AREAS IN THE MINNESOTA RIVER BASIN[1]

Natural Features	Study Area I	Study Area II	Study Area III	Study Area IV	Basin Totals
Waterfall	1	2	0	4	7
Rapids Whitewater	0	2	1	1	4
Beach	1	2	0	0	3
Land Form	6	5	5	10	26
Prairie Remnant	2	4	5	0	11
Scenic Timber	4	2	1	13	20
Rare Flora	1	2	1	6	10
Natural and Scientific Area	4	4	6	23	37
Fish Habitat	1	5	1	1	8
Game Habitat	2	14	3	11	30
View Point or Vista	8	4	4	9	25
Historic Significance	1	5	1	4	11
TOTALS	31	51	28	82	192

[1]From Minnesota Department of Natural Resources document "Natural and Historic Areas of Minnesota", 1971. Subject to change due to site destruction and/or identification of new sites by the Minnesota Department of Natural Resources, Division of Parks and Recreation.

CHAPTER III

ECONOMIC DEVELOPMENT AND PROJECTIONS

III – ECONOMIC DEVELOPMENT AND PROJECTIONS

A. INTRODUCTION

Opportunities for development in the basin are determined by the basin's natural resources, environment, and the existing and future economic conditions. Continued economic growth and higher levels of living are goals of resource planning. Successful resource planning requires projection of economic conditions and their accompanying resource demands. The need for resource development is then evaluated by comparing these future resource demands with available resources.

Included in this chapter are descriptions of historic growth, current economic conditions, and projections of selected indicators. Size and characteristics of the population and labor force are reviewed, as well as sources of income and general industry mix. Due to the nature of this study, greater emphasis is placed on the agricultural economy. Current and projected crop and livestock production is analyzed especially as it relates to crop, pasture, and forest resource requirements.

B. GENERAL METHODOLOGY

Analysis of historic trends and current economic conditions were made primarily from secondary data.

The Minnesota River Basin projections of economic base represent a disaggregated share of two national projection alternatives.[1] The two alternatives relate to the national series C and E' population projections and include projections of population, employment, incomes, and industrial earnings. Also reported are projections of agricultural output associated with the population projections and alternative levels of agricultural export.

The projection alternatives are used for analyzing the needs and effects of future land and water resource development, especially as they relate to agricultural production. A system was developed to evaluate supply capabilities in relation to the projected levels of crop production. Included in the supply estimates are acreages by soil type, level of conservation treatment, and projected crop yields with improved technology and management. The system is also used to measure impacts of changes in resources which include drainage of wet soils, installation of irrigation facilities, and removal of flood hazards.

C. BASIS FOR PROJECTIONS AND DATA LIMITATIONS

The projections are mathematical calculations based on judgmental assumptions about the future. The validity of such projections are only as good as the assumptions used to derive them. Past trends and relationships expected to continue in the future are the necessary basis for any projections. Projection assumptions represent the judgment of many professionals within the U.S. Departments of Commerce and Agriculture, and were adopted by the National Water Resources Council as planning guidelines. They are a consistent set of national projections and are used in all USDA river basin plans.

[1]The 1972 OBERS Projections of Economic Activity, series C and series E', Water Resources Council, Washington, D.C. The agricultural projections were derived from unpublished reports of the Economic Research Service, USDA, Washington, D.C.

The projections alternatives will be referred to as series C and series E' alternatives in this report.[1] The series C represents a higher rate of population growth and a lower level of agricultural production than the series E'. Although different assumptions were used in developing the alternatives, the major differences concern birth rates and agricultural exports. The series C assumes a declining average fertility rate from the 1962-1969 average rate, while the series E' assumes a faster decline which approaches the replacement fertility rate. The series C assumes declining agricultural exports while the series E' assumes a continued high level of exports. Both series were disaggregated to the basin using a similar historic share and trend analysis.

The projections presented here are not to be considered as growth and production goals, but rather as a planning tool to evaluate and measure development opportunities. Neither are these projections intended to be a constraint on the level of resource planning. They merely represent a base level of economic activity for projected years.

D. HISTORICAL DEVELOPMENT

By 1872, over 2,000 miles of railroads had been laid in Minnesota, allowing development of communities on the rich prairie lands. With the railroads, communities were no longer limited to locate along navigable streams. The developing transportation and communication network spread the word of fertile soils in the Minnesota valley quickly, and brought many immigrant families to the area. By 1870, the population in the Minnesota River Basin had grown to over 85,000 persons. At the turn of the century, the population exceeded a quarter of a million persons. This flood of immigration abruptly changed the economic structure of the area from subsistence agriculture, lumbering, and remnants of the fur industry to a commercial agricultural economy with exports of wheat, oats, corn, barley, and potatoes.

E. MAJOR TYPES OF ECONOMIC ACTIVITY

1. Industry Types

For descriptive purposes, industry types are reported in two categories – basic and nonbasic. This breakdown corresponds to those industries which produce goods or services for consumption outside the basin and those industries providing goods or services primarily for basin residents. The basic industries (sometimes referred to as export industries) include agriculture, manufacturing, mining, and forestry. The nonbasic industries include construction, transportation, retailing, wholesaling, and all services. Basic industries are important because they bring new money into the basin's economy which stimulates additional economic activity.

Location quotients are indices used to describe the industrial mix of the basin's economy relative to the U.S. economy. A location quotient equal to one indicates an industry's share of total earnings is the same in both the regional economy and national economy. This implies most output of that industry will be consumed within the region. A location quotient greater than one implies output of that industry is in excess of regional consumption needs and available to be exported. Alternatively, a location quotient less than one implies the need to import products and services of that industry. Location quotients using estimated output of the Minnesota River Basin are given in Table III-1.

[1]Greater detail of assumptions and development of the alternative projections are available in the 1972 OBERS Projections of Economic Activity, series E and series C, reports published by the Water Resources Council, Washington, D.C., and unpublished reports of the Economic Research Service, USDA, on series C and revised series E' agricultural projections.

TABLE III-1. ESTIMATED EARNINGS AND LOCATION QUOTIENTS OF BASIN INDUSTRIES, MINNESOTA RIVER BASIN, 1970

Basic Industries	1970 Earnings ($000)	Percent of Total Earnings	Location Quotient
Agriculture, Forestry and Fisheries	$296,100	32.5	9.7
Mining	1,800	0.2	0.2
Manufacturing, All	145,800	16.0	0.6
Food and Kindred	49,700	5.5	2.4
Printing and Publishing	8,700	1.0	0.6
Fabricated Metals	7,300	0.8	0.4
Machinery	43,000	4.7	0.8
Motor Vehicle and Transportation Equipment	2,800	0.3	0.8
Other Manufacturing	34,300	3.8	0.3
Nonbasic Industries			
Construction	50,100	5.5	0.9
Transportation, Communication, and Public Utilities	30,000	3.3	0.5
Whilesale and Retail Trades	136,700	15.0	0.9
Finance, Insurance, and Real Estate	22,800	2.5	0.5
Other Services	100,200	11.0	0.9
Government	127,500	14.0	0.8
TOTAL	**$911,000**	**100.0**	

The basin's industry mix indicates much specialization in agriculture and some specialization in the manufacture of food and kindred products. Agriculture has dominated the basic industrial output of the basin since early settlement in the latter half of the 19th century.

Manufacturing is the second most important basic industry in the basin. Over 600 manufacturing plants were reported operating in the basin ranging from small family operations with small local markets to large corporations supplying national and international markets. Twenty-four manufacturers were identified in the 1970 census as having sales in excess of $10 million. Seventeen of these were classified as manufacturers of food and kindred products including vegetable processing, livestock and poultry packing, grain milling, and feed preparation. Five others were classified as manufacturers of primary and fabricated metals and machinery. The other basic industries are mining and forestry. However, their output is not sufficient for significant regional export.

Revenue from the sale of agricultural products in various stages of processing is credited for much of the basin's growth and development. Todays' export commodities include corn, soybeans, sugar beets, vegetables, beef, pork, and dairy products. Mining is generally confined to quarrying of rock and limestone which is used locally. Forest resources provide mainly recreation, wildlife habitat, or grazing. Only a limited quantity of wood products are cut. Forest industries and related economic activity are discussed later in this chapter.

The output of nonbasic industries also strongly reflects the dominance of agricultural production with many retail and wholesale businesses providing inputs to agricultural production. Besides the usual retailing of grocery, clothing, fuel, and recreation, many farm supply stores exist in the basin. Fifteen percent of all retail establishments are identified as selling building materials, hardware, and farm equipment. Most transportation is concerned with hauling either farm products or farm inputs. Since the major fixed assets in the basin are the farming and related businesses, the finance, insurance, and real estate businesses are oriented toward those citizens.

2. Industry Relative Earnings

The 1970 earning estimates indicate the relative breakdown of all earnings by major industries (Table III-1). Agricultural accounted for about 32 percent of all basin earnings. Manufacturing accounted for 16 percent of earnings with 5.5 percent coming from food and kindred products manufacture, and 4.7 percent from machinery manufacture. Earnings from wholesale and retail trade businesses and services account for approximately 26 percent of all earnings. Many of the construction, transportation, and communication businesses are based in the Twin Cities. Actual earning to these industries in the basin are relatively small.

The projection of the industrial earnings in Table III-2 represent the two growth alternatives. Total earnings are projected to grow at an average annual rate of 4.3 percent in the series C alternative, and 3.5 percent in the series E' alternative. Output per worker is assumed to increase at an annual rate of 3.1 percent in the series C, and 2.7 percent in the series E'. Although specialization in agricultural production and food and kindred product manufacture is expected to continue, growth in these industries is expected to be much lower than non-basic industries. The greatest growth is expected to occur in the services industries, both private and government.

TABLE III-2. PROJECTED INDUSTRIAL EARNINGS FOR MINNESOTA RIVERS, SERIES C AND SERIES E' ALTERNATIVES, 1970-2020

	1970	1980		2000		2020	
		Series C	Series E'	Series C	Series E'	Series C	Series E'
		1967 ($000)					
Basic Industries	443,700	579,575	609,960	1,039,978	1,012,443	2,171,454	1,622,662
Agriculture and Forestry	291,100	322,539	339,956	429,166	478,137	788,277	679,781
Mining	1,800	4,672	4,277	7,524	5,222	12,400	6,460
Manufacturing	145,800	252,364	265,738	603,288	529,084	1,370,777	936,241
Food and Kindred	49,700	80,252	84,987	155,268	123,749	287,562	177,713
Machinery	43,000	73,690	61,900	191,520	143,257	467,385	273,888
Other Manufacturing	53,100	98,422	118,851	256,500	262,078	615,830	484,640
Nonbasic Industries	467,300	948,425	856,475	2,380,022	1,872,895	5,579,546	3,514,098
Construction	50,100	100,133	86,266	208,620	155,584	391,591	251,267
Transportation, Communication, and Utilities	30,000	49,559	49,757	99,864	102,860	205,402	185,889
Wholesale and Retail Trades	136,700	269,933	246,990	641,934	493,005	1,466,489	874,027
Finance, Insurance and Real Estate	22,800	31,790	29,777	108,800	83,820	224,990	153,353
Other Services	100,200	183,611	190,772	428,184	433,322	939,421	817,296
Government	127,500	313,399	252,913	892,620	604,304	2,351,653	1,232,266
Total Industry Earnings	**911,000**	**1,528,000**	**1,466,435**	**3,420,000**	**2,885,338**	**7,751,000**	**5,136,580**

F. ECONOMIC ACTIVITY INDICATORS

1. Population and Significant Characteristics

The basin's population characteristics and trends are similar to most of rural America. Over the past two decades, the total population has remained quite stable with decreases in the rural population being offset by increases in the larger urban centers. Greater economic opportunity has motivated younger persons to move from farms and small towns to larger towns and cities. This migration has left a slightly older population in many rural parts of the basin.

Total and study area population by place of residence is shown in Table III-3 for 1940-1970. The change in population over the past thirty years was only a 5 percent increase. In comparison, Minnesota's population increased 36 percent, South Dakota's population increased 3.5 percent, and the U.S. population increased 53 percent. This low growth can be attributed to out migration from rural areas. Of the 472,093 persons living in the basin, 36.7 percent are urban residents; 32.0 percent are rural nonfarm residents; and 31.3 percent are farm residents. The basin's urban population represents less than seven percent of Minnesota's urban residents. The 150,000 farm residents are approximately 32 percent of all farm residents in Minnesota.

Although total population change in the basin was minor, significant changes in place of residence did occur between 1950 and 1970. Over 90,000 more persons moved out of the basin than moved into it. Urban population increased over 50 percent, rural nonfarm increased 15 percent, while farm population declined 27 percent. Rural farm population comprised well over one-half the total population in 1940, but steadily declined to less than one-third the 1970 population. A marked variation in population trends exist between the study areas. Total population increased in Study Areas I and IV, and decreased in Study Areas II and III. In Study Areas I, II, and III, rural nonfarm population increased prior to 1960, but started a downward trend during the 1960's. In Study Area IV, rural nonfarm population has continued to increase. Urban population increased and farm population decreased in all study areas.

The population age distribution may be an important factor affecting regional output and economic growth. Persons under 18 years and over 65 years have low employment participation and contribute less toward regional output than persons in the remaining age groups. If a higher proportion of the population is in the nonworking age groups, more earnings must be spent for consumption and less remains for investment. Nationally, 55.7 percent of the population were between ages 18 and 65 in 1970. In Minnesota, 52.9 percent were in this age group, and in the basin only 50.8 percent were in the 18-65 age group.

TABLE III-3. POPULATION BY PLACE OF RESIDENCE, 1940, 1950, 1960, 1970, MINNESOTA RIVER BASIN

		1940	1950	1960	1970
Study Area I	Total	113,888	116,699	125,557	127,495
	Urban	34,014	39,644	50,720	59,218
	Rural Nonfarm	25,780	30,577	35,636	34,192
	Rural Farm	54,094	46,489	39,201	34,085
Study Area II	Total	128,769	127,012	126,719	121,796
	Urban	25,418	33,100	36,958	42,752
	Rural Nonfarm	34,818	34,522	39,060	36,300
	Rural Farm	68,533	59,390	50,701	42,744
Study Area III	Total	93,865	91,313	86,489	79,235
	Urban	18,985	24,296	26,153	27,224
	Rural Nonfarm	21,973	22,247	23,152	23,032
	Rural Farm	52,907	44,770	37,184	28,979
Study Area IV	Total	111,950	114,428	125,846	143,567
	Urban	9,387	18,440	27,938	44,342
	Rural Nonfarm	42,093	43,480	51,436	57,355
	Rural Farm	60,470	52,508	46,472	41,870
Basin	Total	448,472	449,452	464,611	472,093
	Urban	87,804	115,469	141,769	173,536
	Rural Nonfarm	124,664	130,826	149,284	150,879
	Rural Farm	236,004	203,157	173,558	147,678
Minnesota	Total	2,792,308	2,982,483	3,413,864	3,805,069
	Urban	1,390,098	1,624,914	2,122,566	2,527,308
	Rural Nonfarm	402,202	1,357,569	1,291,298	1,277,663
	Rural Farm	905,440	739,799	587,548	454,516

The educational level of persons 25 years and older in the basin is slightly lower than the state average. In 1970, only 31.6 percent of the persons 25 years and older had completed high school, and 7.4 percent had completed four years of college. The state average shows that about 15 percent more completed high school and 5 percent more completed college educations. This lower level of educational attainment is reflective of the rural nature of the basin and the slightly older age of persons living there.

Total population in the basin is projected to increase under both alternatives, series C and E' (Figure III-1). An increase of about 9 percent every decade is projected in the series C alternative and a 4.5 percent increase every decade is projected in the series E' alternative. A continued decrease in rural farm population is projected, but at a lower rate than in the 1940-1970 period. Although agricultural output will increase, total farm labor requirements are assumed to decline with adoption of labor saving technology. As a result, the rural to urban migration pattern prevalent through the last decade is expected to continue.

The estimated study area distribution of projected population is given in Table III-4. The greatest growth is projected in Study Areas I and IV. A continued decline is projected for Study Area III, but at a lower rate than in the 1940-1970 period. Study Area II population is projected to remain relatively stable in the near future, but increase over the longer projected period.

2. Labor Force and Significant Characteristics

About 38 percent of the 1970 population were participants in the basin's labor force. Of the 178,786 workers included in the labor force, 35 percent were female workers. Unemployed workers accounted for 5.3 percent of the civilian labor force. Changes in the labor force have resulted from increased participation rates since 1950, especially for women, as well as changes in the population from natural increase or decrease, and migration. Persistent unemployment and low labor force participation in Study Areas II and III caused an out migration from these areas. Employment opportunities in Study Areas I and IV, however, offset these losses, and a net increase of 8,858 workers was reported for the basin between 1960 and 1970. Three-fourths of this increase is attributed to population gains, and one-fourth to increased participation rates.

Projected total employment in Table III-6 was derived from projected population and assumed employment participation rates. The series C assumes employment participation to remain constant at about 40 percent of the basin's population. The series E' alternative assumes a higher employment participation rate of 42 percent in 1980 and 43 percent in 2000. The projected industry employment in Table III-6 is based on industry earnings and earnings per worker by major industries.

3. Employment by Major Industry Categories

Distribution of the 1970 labor force by industry and study area is given in Table III-5. This breakdown nearly parallels that of industrial earnings with about 35 percent employed in the basic industries, and 65 percent in nonbasic industries. Over 25 percent of the labor force worked in service industries which include all private and professional services, education, and public administration. One of every five workers was employed in agriculture, forestry, or fisheries. Manufacturing employed about 15 percent of the labor force, construction employed 5.6 percent, and mining employed less than one percent. The remaining employment is in transportation, communication, public utilities, wholesale, and retail trade, finance, insurance, and real estate industries. The largest employment changes since 1950 occurred in agriculture and manufacturing industries. The number of agricultural workers has declined to less than one-half the number employed in 1950. During the same time, the number of workers in manufacturing nearly tripled.

Figure III-1

POPULATION TREND AND PROJECTIONS
1940 - 2020, MINNESOTA RIVER BASIN

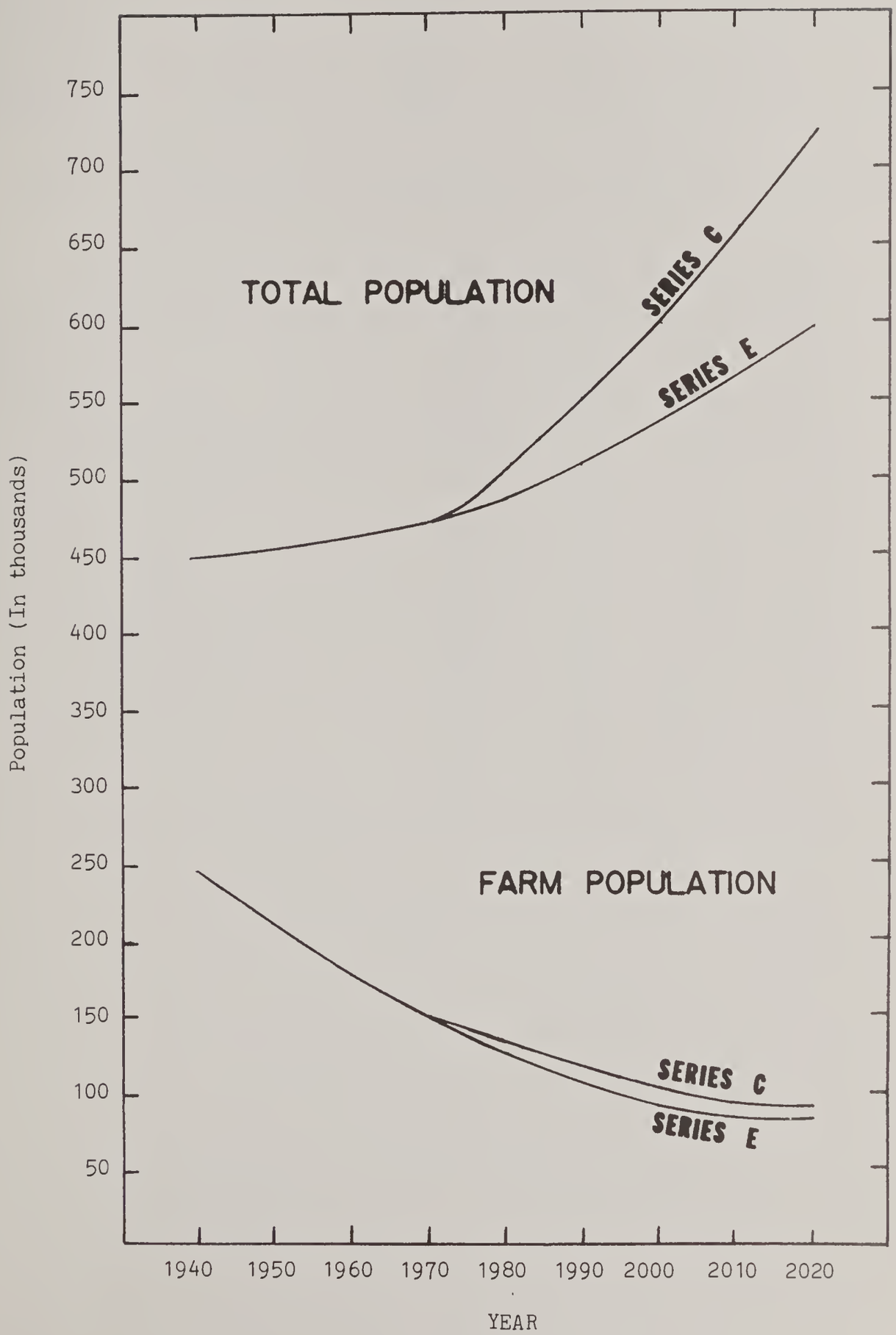


TABLE III-4. STUDY AREA POPULATION PROJECTIONS, SERIES C AND SERIES E' ALTERNATIVES, MINNESOTA RIVER BASIN, 1970-2020

Year (Alternative)	Study Area I	Study Area II	Study Area III	Study Area IV	Basin
1970	127,495	121,796	79,836	143,567	472,093
1980 (Series C)	141,528 •	121,164	74,836	171,564	509,092
1980 (Series E')	134,001	122,540	75,686	155,483	487,710
2000 (Series C)	168,945	118,505	62,595	257,672	607,717
2000 (Series E')	148,072	128,288	74,200	198,816	549,376
2020 (Series C)	209,810	139,873	73,618	312,875	736,176
2020 (Series E')	163,576	138,148	72,710	213,771	588,205

TABLE III-5. CIVILIAN LABOR FORCE BY MAJOR INDUSTRY CLASSIFICATION AND ECONOMIC STUDY AREAS, 1970

Employment Classification	Study Area I	Study Area II	Study Area III	Study Area IV	TOTAL Basin
Agriculture, Forestry, Fisheries	7,404	10,914	7,642	9,090	35,050
Mining	61	39	69	147	316
Construction	2,579	2,413	1,444	3,570	10,006
Manufacturing, All	8,721	5,406	1,828	12,394	28,349
Food and Kindred Products	2,174	2,031	432	2,668	7,305
Textile and Fabricated Textile Products	274	173	19	527	993
Furniture, Lumber, and Wood	142	55	5	352	554
Printing, Publishing and Allied	1,179	462	203	551	2,395
Chemicals and Allied Products	90	57	19	267	433
Metal Industries	635	166	86	1,043	1,930
Machinery and Supplies	2,551	1,160	452	3,493	7,656
Transportation Equipment	343	184	64	517	1,108
Other Manufacturing	1,333	1,118	548	2,976	5,975
Transportation Commission and Public Utilities	2,290	1,918	1,270	2,424	7,902
Wholesale and Retail Trade	11,253	9,604	5,364	10,253	36,474
Finance, Insurance, Real Estate	1,462	1,285	807	1,580	5,134
Services, Excluding Public School	8,656	7,775	4,501	9,170	30,102
Public Schools and Colleges	3,677	2,631	1,978	2,803	11,089
Public Administration	1,254	1,267	1,050	1,350	4,921
Total Employment	47,357	43,252	25,953	52,781	169,343
Unemployment	2,589	1,645	3,085	2,124	9,443
Labor Force	49,946	44,897	29,038	54,905	178,786

TABLE III-6. PROJECTED EMPLOYMENT BY MAJOR INDUSTRY TYPE, SERIES C AND SERIES E' ALTERNATIVES, MINNESOTA RIVER BASIN, 1970-2020

Major Industry	Alternative	1970	1980	2000	2020
Total Basin	Series C	63,685	62,600	67,000	75,000
	Series E'		69,470	75,560	71,210
Agricultural	Series C	35,050	31,500	26,250	22,500
	Series E'		34,174	32,772	26,288
Other Basic	Series C	28,665	31,100	40,750	52,500
	Series E'		35,296	42,788	44,922
Total Nonbasic	Series C	105,658	141,000	176,000	219,500
	Series E'		135,370	160,670	175,840
Total Employment	Series C	169,343	203,600	243,000	294,500
	Series E'		204,840	236,230	247,050

4. Family and Per Capita Income

Family and per capita incomes in the basin lag behind the state average as indicated in Table III-7. The 1970 per capita income of $2,571 is 15 percent lower than the state average. Approximately the same proportion of families in the basin fall into the middle income groups ($5,000-$15,000) as compared to the state average, but a higher proportion fall into the low income groups, and a lower proportion in the high income groups. In 1970, 13.3 percent of the families in the basin had incomes under $3,000, and 13.6 percent had incomes of $3,000-$5,000. Approximately 13.7 percent had incomes exceeding $15,000. For Minnesota, only 18.6 percent of the families had incomes under $5,000 while 22.5 percent had incomes greater than $15,000.

5. Agricultural and Nonagricultural Land Use Projections

The projected economic activity and population growth in the basin will affect the basin's future land uses. Increased acreages will be required for home sites, service, and industrial areas, parks, and transportation routes. At the same time, there will be an increased demand for other land uses including agricultural production, recreation, and wildlife habitat. Agricultural land uses generally cannot compete in the market with other uses. The result is a decreased agricultural acreage as these other land uses increase.

The additional urban and builtup land requirements were derived from population projections and subtracted from the agricultural land inventory. Based on the series C alternative, an additional 13,021 acres will be required for urban uses by 1980. From 1980 to 2000, an additional 34,409 acres is projected to shift to urban uses and for the period 2000 to 2020, an additional amount of 43,299 acres is projected. Urban and builtup land requirements under the series E' alternative are projected to increase 21,424 acres by 2000 with an additional increase of 10,000 between 2000 and 2020.

The 1967 and projected major land uses for each alternative are given in Table III-8. Agriculture is the primary land use. Projected changes through 2020 will result in less than a one percent decrease in agricultural land.

G. TRANSPORTATION

A well-developed transportation network connecting major service centers and providing farm-to-market routes exists throughout the basin. Although only a few miles of interstate highways are built in the basin, other federal and state roads provide excellent intrabasin routes and trunk-lines to Minneapolis-St. Paul, Sioux Falls, and Fargo-Moorhead metropolitan

TABLE III-7. MEAN ANNUAL FAMILY AND PER CAPITA INCOME AND EARNINGS PER WORKER BY OCCUPATION, SOUTHERN MINNESOTA RIVER BASIN, 1970

	Study Area I	Study Area II	Study Area III	Study Area IV	Basin	Minnesota
Family Mean Income	9,922	8,693	8,300	10,205	9,405	11,098
Per Capita Income	2,758	2,414	2,337	2,670	2,571	3,052
Mean Earnings, All Employed Males	7,131	6,415	6,543	7,341	6,930	8,165
Mean Earnings, All Employed Females	2,802	2,605	2,520	2,223	2,533	3,330
Projessional, Managerial and Kindred Workers[1]	10,459	10,067	9,776	11,146	10,498	12,000
Craftsmen, Foremen and Kindred Workers[1]	6,957	6,469	5,928	7,789	7,029	8,269
Operatives, including Transport[1]	5,900	5,652	5,311	6,337	5,954	6,596
Laborers, except Agricultural[1]	3,856	3,739	3,792	5,086	4,256	4,741
Farmers and Farm Managers[1]	7,352	5,784	6,691	5,907	6,348	5,583
Farm Laborers, except Foremen and Unpaid Labor[1]	2,754	2,522	2,482	2,966	2,705	2,777
Clerical and Kindred Workers[2]	2,740	2,616	2,445	2,961	2,749	3,411

[1]Includes only male workers.
[2]Includes only female workers.

TABLE III-8. PROJECTED MAJOR LAND USES, SERIES C AND SERIES E' ALTERNATIVES, MINNESOTA RIVER BASIN, 1967-2020

		Acres			
		1967	1980	2000	2020
Total Area		10,732,040	10,732,040	10,732,040	10,732,040
Noninventory	Series C	719,590	732,610	767,020	810,320
	Series E'		722,640	741,010	751,020
Cropland	Series C	8,214,190	8,205,210	8,181,450	8,151,550
	Series E'		8,213,390	8,202,810	8,200,270
Pasture	Series C	873,700	872,270	868,490	863,730
	Series E'		873,140	870,760	868,890
Forest	Series C	321,870	320,460	316,760	312,110
	Series E'		320,780	317,580	313,970
Other	Series C	602,690	601,490	598,320	594,330
	Series E'		602,090	599,880	597,890

areas. Current and proposed interstate routes nearly surround the basin and provide quick, easy access to areas outside the basin.

Four major rail lines operate in the basin and provide freight service to most towns. The larger towns receive daily service while smaller more remote areas receive only weekly or tri-weekly service. Besides rail freight, much commerce is carried by numerous trucking companies operating within the basin.

Four intercity bus lines provide passenger service to all the larger towns and many small towns in the basin. Major airline service is provided only to Mankato and Fairmont, Minnesota. However, easy access is provided to the Twin Cities International Airport.

H. URBAN CENTERS AND THEIR INFLUENCE

Although most of the Minneapolis-St. Paul metropolitan area is not included in the study area, it has a direct and important influence on the economic activity in the basin. The Twin Cities is a major commerce, financial, and government center for not only the basin, but the entire state and much of the north central region. Most all imports and exports from the basin must pass through the city's wholesale or retail outlets. Many manufacturing plants operating in the basin have main offices in the Twin Cities as do transportation lines and financial and insurance companies. Other metropolitan areas having a lesser effect on the basin's economic activity include Sioux Falls and Fargo-Moorhead.

Except for the expansion of the Twin Cities area into the basin, all other urban areas are relatively small. Their functions for the most part center around the basin's major industry of agriculture. They provide necessary wholesaling, retailing, marketing, processing, and transportation of farm inputs and farm products.

Three cities in 1970 reported populations over 10,000 persons – Mankato, New Ulm, and Fairmont. Twenty-seven other urban areas had a population over 2,500 persons. Mankato, population 40,000, is a center for much economic activity in Study Areas I and IV. Manufacturing plants of fabricated metals, machinery, printing, food, and kindred products employ some 4,000 workers. Mankato State College has also made the city an educational and cultural center. New Ulm, located 28 miles upstream from Mankato, is another industrial city with over 3,000 persons employed in manufacturing. Fairmont is another industrial town located in Study Area I and specializes in food processing and the manufacture of machinery and transportation equipment. Smaller urban centers that perform important regional functions include Marshall in Study Area II, and Montevideo and Morris in Study Area III. Marshall is also an important educational center.

I. INSTITUTIONAL AND SOCIAL STRUCTURE EFFECTS ON THE ECONOMY

The zoning and taxing powers of state and local units of government can have an important effect on local economies. The use of such powers can either enhance or deter the economic growth of an area. All counties, cities, and townships in Minnesota have enabling legislation to pass zoning ordinances. Of course, each of these governmental units have power to collect tax for financing public services. The major services finances include secondary education, road construction and maintenance, and social welfare programs. Another institutional constraint is the permit system for certain uses of surface or groundwater. This institutional arrangement provides a means of monitoring and sometimes restricting the quantity of water uses. It also limits the effluent entering streams, thus affecting the quality of surface water.

High priority has been placed on providing quality educational facilities in the basin. Universities include Mankato State, Southwest State, Gustavus Adolphus, along with junior college and vocational schools in Willmar, Granite Falls, Redwood Falls, and Canby. Total enrollment in these schools in 1970 was 18,026 students.

J. AGRICULTURAL INDUSTRY AND RELATED ECONOMIC ACTIVITY

With agriculture accounting for 32 percent of all earnings and 20 percent of the basin's labor force, it is the largest single industry in the basin. *The 1969 Census of Agriculture* reported 33,906 farms in the basin with an estimated land and building investment of $3.5 billion. Farmers also had an additional investment of $682 million in farm machinery and equipment. The value of all farm sales in the basin was nearly $609 million with approximately two-thirds coming from livestock sales and one-third from crop sales. With agriculture holding such a dominant position in the economy, much of the basin's remaining economic activity is related to this agricultural production or marketing.

1. Agricultural Production

Livestock production has accounted for two-thirds of all farm sales with the sale of cattle and hogs being most important. In 1969, 1.1 million head of cattle and calves were inventoried on the basin's farms. Less than 20 percent were milk cows. An estimated 400,000 head were on feed for beef in 8,500 feedlots. Approximately 100 feedlots of over 500 head operate in the basin. These larger feedlots, however, account for less than 25 percent of total fed beef. Nearly 2.3 million hogs were sold in 1969, and 155,000 sheep and lambs were sold.

The climate and soil conditions in the basin are favorable to the production of most food and feed grains. Corn and soybeans are the primary field crops and are grown throughout the basin. Minnesota ranks third in the nation in total corn production with the Minnesota River Basin producing 4.4 percent of the national production. The 40 million bushels of soybeans currently raised in the basin represent over half of Minnesota's production and about 3.6 percent of the national production. Over half of all cropland in the basin is used to grow corn or soybeans, and 64 percent of the value of all crops is from corn and soybeans. Flax, grown for its seed and oil, is of significant importance in Study Area III.

The production of forage crops to support livestock operation are important, especially in Study Areas II and III. Nearly 20 percent of the total cropland is used for production of silage, hay crops, or pasture. In addition, some 870,000 acres of permanent pasture and 165,000 acres of forest lands are grazed. Total pasture production is estimated to provide 171 million animal unit days of pasture. Approximately 1.5 million tons of hay are produced, and 4 million tons of silage.

2. Crop and Pasture Yields

Soil scientists and agronomists provided current crop yield estimates for each Soil Resource Group (SRG). Different yields were also estimated for wet soils if the SRG contained both drained and undrained land. Yield variation by study areas were also developed to indicate differences due to rainfall and length of growing season. Table III-9 indicates the current (1967-1969 average) yields weighted across all SRG's assumed for study use. Average management practices for each SRG were assumed in these yield estimates.

TABLE III-9. CURRENT NORMAL AND PROJECTED PER ACRE CROP YIELDS, MINNESOTA RIVER BASIN

Crop	Units	Current[1] Normal	1980	2000	2020
Corn	bu	83	111	134	154
Silage	T	12	17	20	22
Soybeans	bu	21	27	31	33
Oats	bu	60	78	93	108
Alfalfa Hay	T	3.2	4.1	4.6	5.4
Other Hay	T	0.9	1.2	1.3	1.6
Cropland Pasture	AUD	133	172	198	226
Improved Pasture	AUD	73	96	110	127
Other Pasture	AUD	41	53	61	70
Grazed Forest	AUD	29	42	48	56

[1]Current normal yields are based on 1967 to 1969 weighted average yield across all SRG's.

Yield projection indices were estimated using historic trends over the past twenty years as a guide. The indices in Table III-10 are the result of this process with adjustment by soil scientists and agronomists. The basis for increased yields include new technology in the development of improved seed varieties or mechanical practices and the adoption of known technology which increases yields. Changing price relationships are assumed to allow the necessary increase in fertilization and adoption of new technology to achieve the projected yields. Yield projections are uncertain, but they are reasonable estimates for analyzing future production.

TABLE III-10. YIELD PROJECTION INDEX BY MAJOR COMMODITY GROUPS PER ACRE[1], MINNESOTA RIVER BASIN

Commodity	1980	2000	2020
Corn for Grain	132	157	180
Soybeans	133	161	186
Small Grains	125	143	157
Corn Silage	138	164	182
Hay and Pasture	131	150	173

[1]1967-1969 = 100.

3. Kinds, Volume, and Value of Farm Output

Current normal and projected crop and livestock production levels were established for the basin. The baseline projections are an allocated share of national food, feed, and fiber requirements. In developing the national projections, consideration was given to domestic population, incomes, consumer consumption patterns, foreign demand for agricultural products, and industrial uses of agricultural products.

A step-wise procedure was used to disaggregate these projections to the State of Minnesota and the water resource subarea associated with the Minnesota River.

Tables III-11 and III-12 report the current normal and alternative projected volumes and values of the basin's agricultural output. Both alternatives project increased levels of crop and livestock production. In general, the series E' projects higher levels of crop production and lower levels of livestock production than the series C.

In the series C, production of meat animals is projected to increase 30 percent by 1980 and 60 percent by 2000. The E' alternative projects a 21 percent increase by 1980 and a 45 percent increase by 2000. Projected increases in milk production are 45 percent by 2000 under the C alternative and 28 percent under the E' alternative. Both alternatives project substantial decline in the basin's egg production.

Estimates of total feed unit requirements were made from projected types of livestock production, feeding efficiencies, and ration compositions. Forage production requirements were then derived from these feed unit consumption levels. It was assumed that pasture land and forest land should continue to be grazed, and the use of cropland for forage production would be limited to meeting any deficiency in pasture production. Only slight changes in current normal forage production are projected for 1980, and less than 15 percent increases are projected for 2000.

In the series C, feed grains are projected to have the greatest increase with current normal output increasing 36 percent by 1980 and 94 percent by 2000. Food grains are projected to increase 35 percent by 1980 and 66 percent by 2000. Soybeans are projected to increase substantially by 1980, but only slight increases are projected thereafter.

TABLE III-11. CURRENT NORMAL AND PROJECTED PRODUCTION AND VALUE OF AGRICULTURAL OUTPUT, SERIES E' ALTERNATIVE.[1] MINNESOTA RIVER BASIN

		Current Normal		1980		2000		2020	
	Units	Production	Dollar Value	Production	Dollar Value	Production	Dollar Value	Production	Dollar Value
				(Thousands)					
Crops									
Corn	bu	201,258	303,900	285,074	430,462	404,094	610,182	457,579	690,944
Soybeans	bu	40,464	166,712	82,912	341,507	113,410	467,249	122,506	504,725
Oats	bu	46,603	34,952	44,067	33,050	66,601	49,951	77,539	58,154
Wheat	bu	4,790	11,975	7,051	17,627	8,899	22,248	10,121	25,303
Rye	bu	1,548	1,734	683	765	466	522	–	–
Barley	bu	1,764	2,223	1,264	1,593	1,044	1,315	674	849
Flax	bu	4,050	17,901	2,391	10,568	1,073	4,743	521	2,303
Hay	T	1,603	40,953	1,620	39,920	1,890	46,573	2,100	51,748
Alfalfa Hay	T	1,448	37,996						
Other Hay	T	155	2,957						
Silage	T	4,093	39,047	4,227	38,888	4,788	44,050	5,110	47,012
Sugarbeets	T	525	9,970	760	14,611	847	16,093	952	18,088
Irish Potatoes	CWT	175	410	247	577	332	776	387	904
Vegetables	CWT	5,475	10,402	8,421	15,999	11,210	21,298	13,233	25,141
Pasture	AUD	171,555	61,416	167,062	59,807	192,035	68,748	202,329	72,433
Livestock									
Beef and Veal	lbs	549,000	188,307	649,402	222,745	797,557	273,562	848,557	291,055
Pork	lbs	533,250	150,430	678,109	191,227	763,842	215,403	792,205	223,402
Lamb and Mutton	lbs	11,093	3,892	6,659	2,337	5,230	1,835	6,918	2,428
Chickens	lbs	30,250	6,231	17,952	3,662	11,599	2,366	7,150	1,459
Broilers	lbs	1,978	403	4,095	835	8,414	1,716	13,638	2,782
Turkeys	lbs	49,350	13,077	72,476	19,206	112,618	29,844	134,230	35,571
Eggs	doz	65,900	20,363	71,375	22,055	42,742	13,207	25,142	7,769
Milk	CWT	22,183	133,319	25,833	155,256	28,340	170,323	33,290	200,073

[1]Total value for crops and livestock are not additive because significant portions of crops are fed to livestock.

In the series E', soybeans are projected to have the greatest increase with current normal output increasing 91 percent by 1980 and 156 percent by 2000. Feed grains are projected to increase 41 percent and 81 percent by 2000. Food grains in the series E' have a projected increase of 35 percent in 1980 and 66 percent in 2000.

4. Current Normal and Projected Crop Yields

A large proportion of the basin's soils are well suited for field crop production and capable of producing high yields. In 1972, the basin's highest average corn yield was attained with 95 bushels per acre. The highest average yield was reported in Subarea I of 109 bushels per acre, while the lowest was in Subarea III with 68 bushels per acre. The highest soybean yields occurred in 1973 with a basin average of 30 bushels per acre. For oats, basin average yield has been as high as 65 bushels per acre, and for wheat, 36 bushels per acre.

Current normal and estimated crop yields are shown in Table III-12. The current normal is based upon an average of 1967-1969 crop yields. Yield projections were made using long term trends and judgments of USDA scientists. The projections assume continued improvements in management, improved types of fertilizer, and increased application, and the development and adoption of new technology regarding varieties and mechanization. The yield projections also assume continued improvement in conservation and land treatment commensurate with the past trend.

TABLE III-12. CURRENT NORMAL AND PROJECTED PRODUCTION AND VALUE OF AGRICULTURAL OUTPUT, SERIES C ALTERNATIVE, MINNESOTA RIVER BASIN

		Current Normal		1980		2000		2020	
	Units	Production	Dollar Value	Production	Dollar Value	Production	Dollar Value	Production	Dollar Value
				(Thousands)					
Crops									
Corn	bu	201,258	303,900	295,199	445,750	380,933	575,209	483,137	729,537
Soybeans	bu	40,464	166,712	71,798	295,808	76,453	314,986	77,570	319,588
Oats	bu	46,603	34,952	45,846	34,385	56,547	42,410	60,262	45,197
Wheat	bu	4,790	11,975	6,275	15,688	8,047	20,118	9,436	23,590
Rye	bu	1,548	1,734	557	624	310	347	–	–
Barley	bu	1,764	2,223	1,252	1,578	1,005	1,266	670	844
Flax	bu	4,050	17,901	2,228	9,848	972	4,296	486	2,148
Hay	T	1,603	40,953	1,600	40,902	1,877	48,414	2,134	54,893
Alfalfa Hay	T	1,448	37,996	1,449	38,021	1,760	46,182	1,980	51,955
Other Hay	T	155	2,957	151	2,881	117	2,232	154	2,938
Silage	T	4,093	39,047	4,175	39,829	4,707	44,904	5,205	49,656
Sugarbeets	T	525	9,970	590	11,204	800	15,192	1,080	20,509
Irish Potatoes	CWT	175	410	245	573	350	819	472	1,104
Vegetables	CWT	5,475	10,402	8,500	16,150	11,930	22,667	16,095	30,580
Pasture	AUD	171,555	61,416	179,682	64,326	188,374	67,438	205,735	73,653
Livestock									
Beef and Veal	lbs	549,000	188,307	768,600	263,629	988,200	338,952	1,235,250	423,691
Pork	lbs	533,250	150,430	639,900	180,516	709,250	200,079	810,540	228,653
Lamb and Mutton	lbs	11,093	3,892	12,313	4,321	14,975	5,255	18,414	6,461
Chickens	lbs	30,250	6,231	16,940	3,489	25,712	5,297	35,998	7,416
Broilers	lbs	1,978	403	1,980	404	4,747	968	7,912	1,614
Turkeys	lbs	49,350	13,077	72,051	19,094	109,557	29,033	163,842	43,418
Eggs	doz	65,900	20,363	59,310	18,326	37,500	11,587	–	–
Milk	CWT	22,183	133,319	23,292	139,984	32,165	193,311	42,148	253,309

These projected levels of farm output indicate an increased requirement for all livestock products, except chickens and eggs. Beef production is projected to increase 80 percent by 2000, and 125 percent by 2020. Pork production is projected to increase 33 percent by 2000, and 52 percent by 2020. A 45 percent increase in milk production is projected for 2000 and an additional 45 percent increase by 2020. Increases in poultry production with the exception of eggs are also projected. Egg production is projected to decline by 43 percent by 2000.

K. FARM EMPLOYMENT AND INCOME

Approximately 35,000 persons are employed in agriculture in the basin with almost all workers being farm operators. Hired farm laborers make up less than 10 percent of the labor force. Vegetable crops and sugarbeets, however, do require significant amounts of seasonal labor, and much of this is supplied by migrant workers. The mean farm income reported in 1970 for the basin was $4,700. As a result of this low income and the availability of capital equipment to replace labor, agricultural employment has continued to decline at a rate of nearly 2,000 persons annually.

L. FOREST, INDUSTRY, AND RELATED ECONOMIC ACTIVITY – HISTORICAL, PRESENT AND PROJECTED

Prior to settlement, most of the Minnesota River Basin was prairie with dense grass vegetation. This vegetative type was maintained primarily by buffalo grazing and wild fires. Trees, mainly oak, ash, elm, maple, basswood, and cottonwood, were confined primarily to hills, ravines,

valleys, and river bottom locations. During settlement (1840-1880), woodlots were planted around homesteads for firewood, shade, and shelter. Under this use, the forest lands actually increased in total area.

About 1895 the dairy industry started to develop on farms which had previously been used largely for grain crops. The number of cattle increased, and because it was profitable, they were turned into the woods. No factor has been more important in the deterioration of farm woodlands than the grazing of domestic livestock.

From early settlement to the present time, the forest industry has been small and locally oriented. Most of the sawmills have been owned and operated by farmers for a secondary income or for private use. In some larger cities, industries which use wood as a raw material have been developed for the manufacture of furniture, fixtures, boxes, and other similar products, but these industries used relatively small amounts of woods, most of which must come from outside sources.

1. Extent and Nature of Forest Resources

Table III-13 shows the extent of the forest land in the Minnesota River Basin. The percentage of the study area occupied by commercial forest land is also given.

Eighty-five percent of the commercial forest lands are hardwood types (Table III-14). Lowland hardwoods, located on wetter soils in the flood plains of the rivers, make up the largest forest type in the basin.

Current ownership of commercial forest land is given in Table III-15. Eighty-one percent of the commercial forest land is owned by small private owners. The large percentage of private small ownerships is not conducive to a high level of forest land management. Factors which have an adverse effect on the management by small private ownerships in the basin include the small acreages in each ownership, the short period of ownerships, the small percentage of a landowner's income that is provided by his woodlands, and the poor quality of the timber resource in the basin.

TABLE III-13. FOREST LAND ACREAGES AND PERCENT OF COMMERCIAL ACREAGES BY STUDY AREAS[1]

Areas	All Forest Land	Noncommercial Forest Land	Commercial Forest Land	Percent of Study Area that is Commercial Forest Land
I	55,206	3,312	51,894	3
II	66,120	4,628	61,492	2
III	87,100	12,194	74,906	3
IV	114,030	11,403	102,627	5
BASIN TOTAL	322,456	31,537	290,919	3

TABLE III-14. AREA OF COMMERCIAL FOREST LAND BY FOREST TYPE IN THE MINNESOTA RIVER BASIN[1]

Forest Type	Study Areas (Acres) I	II	III	IV	Basin Total
Pine	152	1,050	1,270	2,020	4,492
Mixed Swamp Conifer	–	1,110	2,630	4,070	7,810
Northern Hardwoods	5,162	5,040	8,470	12,410	31,082
Oak	11,386	4,880	18,310	19,680	54,256
Lowland Hardwoods	24,365	40,040	18,090	23,310	105,805
Aspen-Birch	531	3,010	19,990	31,920	55,451
Grass and Upland Brush	8,274	1,840	1,700	2,660	14,474
Lowland Brush	2,049	4,220	4,150	6,400	16,819
TOTAL OF ALL TYPES	51,919	61,190	74,610	102,470	290,189

[1]Source – Minnesota Forest Survey

TABLE III-15. CURRENT OWNERSHIP, COMMERCIAL FOREST LAND[1]

Study Area	Public	Private Forest Industry	Private Small Ownership	All Ownership
I	9,867	46	42,006	51,919
II	14,210	30	46,950	61,190
III	12,760	70	61,780	74,610
IV	17,410	100	84,960	102,470
TOTAL	54,247	246	235,696	290,189

[1]Source – Minnesota Forest Survey.

2. Forest Industry's Contribution to the Economy

A good measure of the contribution of an industry to the economy of an area is to determine the value added by manufacturers. This information is shown in Table III-16.

TABLE III-16. VALUE ADDED BY MANUFACTURERS AND PERCENT TOTAL VALUE ADDED ATTRIBUTABLE TO FOREST INDUSTRIES, 1974[1]

Study Area	Total Value Added by Forest Industries in the Basin for 1974 ($1,000)	Total Value Added for All Manufacturers in the Basin for 1974 ($1,000)	Percent Total Value Added Attributable to Forest Industries (%)
I	8,120	281,300	2.9
II	2,679	132,222	2.0
III	1,347	32,211	4.2
IV	32,882	746,398	4.4
TOTAL	45,028	1,192,131	3.8

[1]Source – Minnesota Economic Data, Counties and Regions.

3. Kinds, Volume, and Value of Forest Products

Table III-17 contains information on the forest products sold off commercial farms.

TABLE III-17. KINDS, VOLUME AND VALUE OF FOREST PRODUCTS SOLD OFF COMMERCIAL FARMS IN 1969 IN THE MINNESOTA RIVER BASIN

Kinds	Study Area I		Study Area II		Study Area III		Study Area IV		SMRB TOTALS	
	Volumes	Values	Volumes	Values	Volumes	Values	Volumes	Values	Volumes	Values
Standing Trees Stumpage*	2,330,000 Bd. Ft.[1]	$ 58,250	381,600 Bd. Ft.	$ 9,540	59,600 Bd. Ft.	$1,490	651,500 Bd. Ft.	$16,290	3,422,800 Bd. Ft.	$ 85,570
Saw Logs and Veneer Logs**	1,235,140 Bd. Ft.	$216,160	43,090 Bd. Ft.	$ 7,540	3,490 Bd. Ft.	$ 610	95,540 Bd. Ft.	$16,720	1,377,260 Bd. Ft.	$241,020
Firewood	30 Cords	$ 1,050	66 Cords	$ 2,300	55 Cords	$1,930	60 Cords	$ 2,120	211 Cords	$ 7,400
Pulpwood[2]	–	–	–	–	62 Cords	$ 980	–	–	62 Cords	$ 980
Specialty Products[3]	Various Items	$ 3,800	Various Items	$ 6,800	Various Items	$1,640	Various Items	$ 7,140	Various Items	$ 19,380
TOTAL		$279,250		$26,180		$6,650		$42,270		$354,350

[1]Board Feet, International 1/4 inch.
[2]Trees used in the manufacturing of paper and other similar products.
[3]Products such as maple syrup and Christmas trees.

*Prices paid to the landowner for trees standing in the woods.
**Prices paid for logs he personally cut and delivered to the mill.

Source – Minnesota Forest Survey.

4. Employment and Income in Primary and Secondary Processing

Table III-18 contains the number of employees working in the two standard industrial classifications which use forest products.

The average monthly salary per employee, using 1974 data for each industry is: lumber and wood – $681, and furniture and fixture – $435. The annual payroll of the forest industries is approximately $7,000,000.

TABLE III-18. EMPLOYMENT IN PRIMARY AND SECONDARY FOREST INDUSTRIES IN THE MINNESOTA RIVER BASIN, 1974[1]

Study Areas	Number of Employees	
	Lumber and Wood	Furniture and Fixtures
I	109	77
II	89	19
III	44	35
IV	198	537
TOTAL	440	668

[1]Source – Minnesota Department of Manpower Services.

5. Projections

In the next 50 years, the demand for all wood products will increase. To help meet this demand, the Upper Mississippi River Comprehensive Study predicts that the harvest of sawlogs and veneer lots in the basin will increase by 74 percent. The increase in output will require an increase in employment, and it is estimated that employment in the lumber and wood industry will increase by 47 percent. Even with these increases, forest industries will not become a significant part of the basin's economy.

CHAPTER IV

LAND AND WATER RESOURCE PROBLEMS AND NEEDS

A. INTRODUCTION

Problems and needs discussed in this chapter are the result of meetings, interviews, and discussions held throughout the basin with local citizens, policy committees, and technical field personnel. Problems identified in the study areas and the order of importance are as follows:

Study Area I

1. Flooding
2. Drainage
3. Erosion
4. Lake and Stream Pollution
5. Irrigation
6. Environmental Quality

Study Area II

1. Flooding
2. Drainage
3. Erosion
4. Pollution
5. Recreation, Fish and Wildlife

Study Area III

1. Erosion and Sediment
2. Pollution
3. Land Use Control
4. Recreation
5. Drainage
6. Fish Resources
7. Wildlife Resources
8. Flooding
9. Irrigation

Study Area IV

1. Land Use Control
2. Erosion and Sediment
3. Drainage
4. Pollution
5. Recreation
6. Flooding
7. Wildlife Resources
8. Lake Level Regulation
9. Water Supply

These land and water resource problems are the results of man's lack of understanding of the capabilities of the resources and his desire to use the resource for maximum economic gains.

In recent years, the restoration and conservation of these resources have become major concerns. Since the nineteen thirties, damaging practices in the use of land and water have been recognized and identified. Physical capabilities of land and water were studied. Land-users have generally accepted the conservation concepts and their applications. However, with all of the research that is involved and the energy and monies being spent in the field of resource conservation, significant problems still remain. This cahpter discusses some of the physical problems of the basin.

B. SOIL EROSION

The most significant erosion problem in the basin is sheet and rill erosion caused by wind and/or water runoff. Sheet erosion is the removal of a relatively uniform layer of soil. Rill erosion is the formation of shallow channels that can be smoothed out by normal cultivation.

Sheet and rill erosion has caused the gradual removal of the more productive top soils, and, to a limited degree, has exposed the agriculturally less productive subsoils and parent materials. The loss of topsoil has resulted in reduced natural productivity in some areas. Sheet erosion is a potential problem on all soils under adverse conditions, but especially on sloping soils and on soils devoted to cultivated crops.

The rate of sheet and rill erosion, as well as gully erosion, depends on many factors – rainfall, slope steepness and length, vegetative cover, soil type, and management.

Erosion is generally more severe in early spring because vegetation on cultivated land is not fully established. Raindrops striking the soil have a large amount of energy. This energy is the moving force that causes erosion to begin.

Sheet and rill erosion cause the gradual removal of the productive topsoil.

Following are conditions that cause soil erosion, and increased sediment yield potential on agricultural land in the basin:

1. Sloping land which is farmed without erosion control practices
2. Rows up and down moderate to steep slopes
3. No crop residues on the surface after new crop seeding
4. No cover between harvest and establishment of new crop canopy
5. Intensively farmed land adjacent to streams without intervening strip of vegetation
6. Runoff, from upslope pasture or woodland, flowing across cropland
7. Poor stands or poor quality vegetation
8. Poorly managed pasture, idle, or wooded areas
9. Nonvegetated areas.

There are 4,158,100 acres of crop, pasture, forest, and other agricultural lands on which the major limitation or dominant problem is the erosion hazard. These soils, constituting nearly 42 percent of all agricultural land in the basin, are subject to moderate to very severe erosion by water, and/or wind, unless protected. It is estimated that 3,389,200 acres (82 percent) of land with this erosion hazard are utilized as cropland. There are 179,000 acres of pasture, 192,300 acres of forest land, and 196,800 acres of other agricultural land which also have an erosion hazard. Table IV-1 is an inventory of the agricultural land in the basin with erosion hazards.

TABLE IV-1. INVENTORY OF AGRICULTURAL LAND WITH EROSION HAZARDS BY CLASS-SUBCLASS[1], MINNESOTA RIVER BASIN

Item	IIe	IIIe	IVe	VIe	VIIe	Total
			(Thousand Acres)			
Cropland	2,501.9	680.3	146.8	50.4	9.8	3,389.2
Pasture	111.2	88.7	74.7	68.0	37.2	279.8
Forest	51.4	19.9	20.8	23.4	76.8	192.3
Other	137.5	33.5	9.4	7.9	8.5	196.8
TOTAL	2,802.0	822.4	251.7	149.7	132.3	4,158.1

[1]From 1967 Conservation Needs Inventory.

Although erosion hazard exists on pasture, forest, and other agricultural land, the problem is not as significant as that existing on cropland. These uses do not generally present an immediate sheet and rill erosion problem because they are not cultivated; however, there are significant amounts of pasture and woodland on IVe-VIIe capability soils which could be a very severe erosion problem, especially if conversion of these marginal lands continues with the demand for increased production. At present, over 90 percent of the estimated 32,000,000 tons per year gross soil loss, on all agricultural land of all land capability classes in the basin, occurs on cropland. Total erosion has been estimated using land capability classes and general relationships suitable for the Universal Soil Loss Equation.

Although the 3,389,200 acres of cropland with erosion hazards represents only 40 percent of the total cropland in the basin, erosion on this same land accounts for nearly two-thirds of the total gross soil loss occurring on cropland. Table IV-2 displays the percent of total cropland by capability class and the percent of total soil loss on cropland by capability class. The breakdown includes soils with erosion hazards, class I soils with few limitations, subclass "w" soils with dominant excess water problems, and subclass "s" soils with dominant limitations because of soil conditions such as soil depth, or available water capacity. Soil erosion on the latter three categories generally does not exceed tolerable levels for substained productivity with exception to wind erosion on subclass "s" soils during drought years or similar adverse conditions. The table also shows comparative data for areas I-IV.

Judged against current standards, about 26 percent of the cropland with erosion hazards is adequately treated such that current conservation treatment is adequate to meet the conservation problem. This leaves 2,490,000 acres with problems needing treatment for erosion control alone. Soil loss on these acres is currently in excess of tolerable levels of 4 tons/acre/year. Almost three-fourths of locally controlled cropland with erosion hazards is not being cared for in a way that protects the soil resource for sustained production. It should be clarified, however, that as shown in Table IV-2, nearly 60 percent of the cropland soils in the basin have dominant problems other than erosion hazard. Table IV-3 shows acres of land adequately treated, those needing treatment and the resultant soil loss per year.

TABLE IV-2. PERCENT TOTAL CROPLAND BY CAPABILITY CLASS, CAPABILITY SUBCLASS, AND PERCENT TOTAL SHEET AND RILL SOIL LOSS ON CROPLAND BY CAPABILITY CLASS AND CAPABILITY SUBCLASS, MINNESOTA RIVER BASIN, 1974

	STUDY AREA I		STUDY AREA II		STUDY AREA III		STUDY AREA IV		TOTAL	
Class	Percent Total Crop	Percent Total Soil Loss	Percent Percent Total Crop	Percent Total Soil Loss	Percent Total Crop	Percent Total Soil Loss	Percent Total Crop	Percent Total Soil Loss	Percent Total Crop	Percent Total Soil Loss
I	11.0	12.1	11.5	9.2	10.8	7.5	14.3	14.8	11.8	10.2
IIe	24.8	40.0	35.2	50.5	32.5	40.2	26.5	43.1	30.4	44.3
IIIe	6.9	13.2	7.5	12.8	12.6	18.6	5.7	10.7	8.3	14.2
IVe	0.9	2.4	1.7	3.4	3.1	5.3	1.4	3.1	1.8	3.7
VIe	0.3	1.1	0.3	0.9	1.3	3.5	0.5	1.4	0.6	1.8
VIIe	0.1	0.5	0.1	0.2	0.1	0.3	0.2	0.9	0.1	0.4
"W"	52.0	22.8	38.6	13.8	30.4	10.0	48.7	21.0	41.6	15.6
"S"	4.0	7.9	5.1	9.2	9.2	14.6	2.7	5.0	5.4	9.8

TABLE IV-3. CONSERVATION TREATMENT AND SOIL LOSS ON AGRICULTURAL LAND, MINNESOTA RIVER BASIN, 1974

Land Use	Study Areas	Total Acres (000)	Land Adequately Treated		Land Needing Treatment		Soil Loss Tons/Yr. (000)
			Acres (000)	Percent	Acres (000)	Percent	
Cropland	I	1,866	681	36	1,185	64	5,782
	II	2,741	970	35	1,771	65	10,201
	III	2,019	705	35	1,314	65	8,422
	IV	1,588	560	35	1,028	65	5,033
	Basin Total	8,214	2,916	36	5,298	64	29,438
Pasture	I	68	14	21	54	79	109
	II	303	83	27	220	73	554
	III	356	120	34	236	66	662
	IV	146	39	27	107	73	238
	Basin Total	873	256	29	617	71	1,563
Forest	I	55	24	43	31	57	33
	II	66	24	36	42	64	46
	III	87	37	43	50	57	61
	IV	114	38	33	76	67	80
	Basin Total	322	123	38	199	62	220
Other	I	96	75	78	21	22	92
	II	174	124	71	50	29	217
	III	206	152	74	54	26	251
	IV	126	99	79	27	21	124
	Basin Total	602	450	75	152	25	584
Total	I	2,085	794	38	1,291	62	6,016
	II	3,284	1,201	37	2,083	63	11,018
	III	2,668	1,014	38	1,654	62	9,396
	IV	1,974	736	37	1,238	63	5,475
	Total	10,011	3,745	37	6,266	63	31,905

Wind erosion is a potential problem in localized areas of the basin, but overall is not a major problem. Wind erosion occurs where top soils are sandy or very light textured, especially during drought years when plant cover is inadequate. In addition to the "e" soils with a dominant water erosion hazard, there are 590,000 acres of capability subclass "s" soils with dominant limitations because of unfavorable soil conditions, such as soil depth, or available water capacity, the latter of which are especially susceptible to wind erosion during drought years, if not protected. In localized problem areas, airborne soil can act as an irritant to people. In addition, deposition in ditches and waterways can result in considerable costs for removal.

Gully erosion, caused by flowing water, results in the formation of channels that cannot be smoothed out by normal cultivation. It is accelerated by the lack of vegetative cover and is generally most severe in cultivated areas on rolling topography. Upland gully erosion studies in forest areas show that undisturbed forest land normally has few gullies and yields little overland flow, even under severe runoff conditions. However, there are localized erosion problems which have occurred as a result of grazing, poor management, or intensive land use above steeply sloping forest land.

Gullies adjacent to the Minnesota River, degrading of ephemeral waterways, and drainage outlets in the subwatersheds are the major concerns. Loss of land to advancing gullies and the resultant deposition of sediment is a problem. Gully erosion destroys land by creating a void where the gully is formed. Gullies lower the utility of the land adjacent to them and damage roads, railroads, buildings, and fences. The gullies are also a hazard to the farm operators and their livestock.

In severely gullied areas, the annual gross soil loss can be as high as 400 tons per acre (Ursic and Dendy, 1963). Gully erosion damages an estimated 150 acres annually and causes an average damage of $100,000.

The annual gross soil loss can be as high as 400 tons per acre in gullied areas like this.

Streambank erosion is the removal of soil from the sides of rivers and streams. This soil removal occurs principally during flood flows. About 200 miles of streambank within small watersheds (400 square miles or less) are affected by erosion, but damage is considered severe on about 30 miles. It is estimated that 7.2 acres per year are destroyed as a result of this erosion. Other problems, in addition to loss of land, include deposition of infertile sediment and dredging costs for maintenance of navigable channel on the lower several miles of the Minnesota River. The U.S. Army Corps of Engineers have studied those areas which are greater than 400 square miles in drainage areas.

Streambank erosion is considered severe on about 30 miles of the basin's streams.

Shoreline erosion is not a major problem in the basin. Seiche effect, which is a back and forth movement of water and results in fluctuation of the water level in certain lakes, causes some shoreline erosion. Monetary damages have not been studied.

Roadside erosion is a minor problem in contrast to the entire erosion problem. Erosion on road right-of-ways produces a sediment problem and is aesthetically unpleasing. In certain instances, it may create a safety hazard. An inventory of the nature and extent of the roadside erosion problem has been completed by the Minnesota Highway Department. The total volume of soil displacement from eroded areas is estimated to be 1.1 million tons. Over two-thirds of the total volume has occurred in Blue Earth, LeSueur, Nicollet, and Sibley Counties. Forty percent has occurred in Nicollet County alone and this is the most significant roadside erosion problem in the basin. This problem has resulted from instability on the steep slopes formed by the cutting and scraping of bluffs in the construction of U.S. Highway 169 adjacent to the Minnesota River. Significant problems in LeSueur County are the result of construction of township roads which were cut through the bluffs along the Minnesota River. Other problems in the basin include the undermining of the roadway structure and the use of roadside ditches as outlets for agricultural drainage. These problems result in a continued need for maintenance, replacement, and special roadside erosion control measures.

Erosion resulting on construction sites on agricultural lands, and urban and builtup non-inventory land can be a serious problem if proper precautions are not taken. Erosion rates in excess of 30 tons per acre can occur on land with moderate to serious erosion hazards. The small total area in the basin affected by erosion on construction sites at any one time, and the short duration of general construction activities during which soil is susceptible to erosion, make this problem only a small aspect in relation to the total erosion problem.

C. SEDIMENT

Sedimentation is a problem in the Minnesota River Basin (see Figure IV-1). The Minnesota River itself is a major sediment polluter of the Mississippi. Most of the lakes in the basin are undergoing sedimentation to some extent, and Big Stone Lake is undergoing severe sedimentation. Major drainage channels within the basin require periodic cleaning to remove accumulated sediment. The Mississippi is one of the few major rivers in the world where the sediment load per unit of watershed area increases as the drainage area becomes larger. The Minnesota River is the major source of sediment pollution to the Mississippi above its outlet into Lake Pepin and is responsible for this reversal in sediment yields. The St. Croix River and the Mississippi River above its junction with the Minnesota are practically clear water streams even at flood stage. However, the Minnesota River carries a heavy sediment load even under normal conditions. The high percentage of cropland in the Minnesota's drainage area is responsible for the differences in sediment yield.

The major source of sediment in the basin is sheet erosion from cropland. Other types of upland erosion, such as gullying and roadside erosion, are locally severe but do not constitute a significant source of sediment pollution. Streambank erosion is not a major source of sediment due to the presence of erosion resistant material. Wind erosion on bare farmland is a major source of dust which has an adverse effect upon air quality within the basin. Airborne sediment pollution is a problem principally in the fall and early spring.

Sediment fills lakes, reduces stream capacity and is a major water pollutant.

The present emphasis in conservation farming is protecting the soil resource base for continued productivity. Reducing the rates of soil erosion to within the tolerable soil loss for the soils within the basin would not significantly reduce sediment pollution. A dramatic decrease in sediment pollution would require a combination of conservation farming measures designed principally for sediment abatement and mechanical control measures such as desilting dams to trap sediment.

D. PRESENT STATUS AND NEED FOR LAND STABILIZATION AND CONSERVATION MANAGEMENT SYSTEMS

The application of measures that provide protection and management, including all types of conservation treatment and practices, is a basic need in the conservation, development and utilization of land and water resources. Protection and management measures are needed for crop, pasture, forest, and other agricultural lands throughout the basin.

Land is placed in capability classes because of the degree of hazards to the soil and water resource from crop production as well as other uses. The hazards are grouped into subclasses or major problems. They are: erosion, wetness, and limitations due to soil characteristics. The higher the class number, the greater are the hazards and the greater the need for conservation or resource development practices to offset the effect or the severity of the problem.

For example, terraces, stripcropping, or mulch tillage, combined with a good legume-grass rotation, can make hilly erosive land productive without losing valuable soil. Tile or ditch drainage systems or dikes and dams for flood control can make wet soils very productive. Where water is available for irrigation, droughty lands can become manageable and productive areas. Fertility management is generally needed even on Class I soils. Crop residue management and minimum tillage are desirable practices for maintaining and building soil structure on all classes of land.

Crop residue will protect and improve the soil.

U. S. DEPARTMENT OF AGRICULTURE

SEDIMENT SOURCE AREAS

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE IV-1

5-5-76

5,S-35,648

The 1967 Soil and Water Conservation Needs Inventory was used as base data for the Minnesota River Basin. An update to 1974 was accomplished through utilization of existing trends and conservation accomplishments through the judgment and knowledge of individuals within individual counties. It is not based on statistical sampling as was done in 1967. Table IV-4 gives a breakdown of the treatment status and conservation treatment needs on agricultural land in the basin by major land use. Treatment needs reflected in the table are for the major intensity level of treatment needed for each land use. Certain acres, however, may need the application of a combination of conservation practices.

TABLE IV-4. CONSERVATION TREATMENT NEEDS[1], MINNESOTA RIVER BASIN, 1974

Practice or Activity	Acres		
	Treatment Adequate[2]	Treatment Needed	Total
CROPLAND			
Residue and Annual Cover	1,199,090	685,590	1,884,680
Sod in Rotation	289,410	1,171,750	1,461,160
Contouring Only	197,700	499,060	696,760
Stripcropping, Terracing, Diversions	171,070	907,660	1,078,730
Permanent Cover	90,620	65,470	156,090
Drainage System	967,120	1,969,650	2,936,770
Total Cropland Area	2,915,010	5,299,180	8,214,190
PASTURE			
Needs Protection Only	134,380	353,330	487,710
Needs Improvement Only	69,670	110,860	180,530
Reestablishment of Vegetative Cover	33,940	71,320	105,260
Brush Control and Improvement	17,790	34,300	52,090
No Treatment Feasible	–	41,740	41,740
Change in Land Use	–	6,370	6,370
Total Pasture Area	255,780	617,920	873,700
FOREST			
Commercial Forest Land	100,100	190,090	290,190
Establishment and Reinforcement	–	(70,900)	–
Timber Stand Improvement	–	(119,190)	–
Non-Commercial Forest	22,270	9,410	31,680
Total Forest Area	122,370	199,500	321,870
Forest Land Grazed[3]			
Needs Forage Improvement	–	31,940	–
Grazing Reduction or Elimination	–	91,960	–
Total Forest Land Grazed	20,400	123,900	144,300
OTHER LAND			
Total Other Land	450,780	151,910	602,690
Total Agricultural Land	3,743,940	6,268,510	10,012,450

[1]Updated from Soil and Water Conservation Needs Inventory data for 1967.
[2]This is land on which the current conservation treatment is adequate to meet the conservation problems.
[3]An alternative use of forest land. Data developed only for commercial forest. Does not include forest land not grazed.

There is a total of 10,012,000 acres of agricultural land in the Minnesota River Basin, of which 3,744,000 acres, or 37 percent, are adequately treated.

Eight-two percent of the agricultural land in the basin, or 8,214,000 acres, is devoted to crop production. Thirty-six percent of all cropland is adequately treated; 8 percent has a major need of residue and annual cover; 14 percent needs sod in rotation or comparable level of

management; 6 percent needs contouring; 11 percent needs stripcropping, terraces, or diversions; nearly 1 percent needs conversion to permanent cover; and 24 percent has major needs of improved drainage.

The land treatment for cropland is presented in Table IV-4. Five of the treatment practices emphasize production and erosion hazard control, while the sixth emphasizes wetness hazard control and resultant increased productivity. Erosion hazard categories range from slight to very severe.

When erosion hazard is slight, it was assumed that residue, annual cover, or minimum tillage was the most likely alternative for treatment. When the degree of erosion hazard increased to moderate, sod in rotation or contouring was selected. Sod in rotation has been used as a soil productivity maintenance practice, and it also has merits in reducing susceptibility of soils to erosion as part of the overall rotation. With increasing demand for grain crops and continued availability of commercial fertilizers, the use of sod in rotation as a practice will likely decrease. It appears that residue management and the newer and increasingly acceptable forms of reduced and minimum tillage, along with application of commercial fertilizers, may be substituted for much of this need. In certain cases, contouring combined with minimum tillage can meet the conservation need on soils with a severe erosion hazard. For these soils, however, stripcropping, terraces and diversions were assumed as being the most likely alternatives. Where the erosion hazard of cropland could not be diminished to a tolerable level by treatments, the alternative selected was to change the land use to permanent cover, either grass or trees.

Minimum tillage protects the soil from erosion and conserves moisture.

The major treatment need for soils with a wetness problem was generally assumed to be surface and subsurface drainage systems. This subject will be discussed in greater detail in Section F of this chapter.

Nearly 9 percent, or 873,000 acres, of the agricultural land in the basin is devoted to pasture. Twenty-nine percent of the pastureland is adequately treated, 40 percent needs protection from overgrazing only, 13 percent needs improvement only, 8 percent needs reestablishment of vegetative cover, 4 percent needs brush control and improvement, 5 percent is not economically feasible to treat, and less than 1 percent needs a change of land use to woodland.

Only 322,000 acres or slightly more than 3 percent of the basin is devoted to forest and woodlands. Thirty-eight percent of the forest land is adequately treated, 22 percent needs establishment and reinforcement, 37 percent needs timber stand improvement and 3 percent is noncommercial forest needing varied treatment. Nearly 50 percent of all commercial forest in the basin is grazed. Fourteen percent of commercial forest land grazed is adequately treated in regard to grazing, 22 percent needs forage improvement and 64 percent needs grazing reduction or elimination.

Six percent of the agricultural land in the basin is devoted to other land uses. Other land is nonfederal rural land not classified as cropland, pasture or forest. This includes farmsteads, farm roads, feedlots, ditch banks, fence rows, small stock ponds, small shelterbelts, certain wetlands, wildlife lands, rural nonfarm residences, borrow acres, churches, and cemeteries. Seventy-five percent of the other land in the basin is adequately treated. The remaining 25 percent needs varied forms of treatment including erosion control, farmstead windbreaks or shelterbelts and agricultural waste management systems.

E. FLOODWATER

Flooding is one of the primary concerns in Study Areas I, II, and along the Minnesota River. It is of less concern in Study Areas III and IV, even though 60,000 acres have flood damages. Cropland and pasture flooding occurs on 28,000, 302,000, and 195,100 acres, respectively, in Study Areas I, II, and along the Minnesota River (see Major Flood Damage Areas, Figure IV-2).

In Study Area II, there are five principal tributaries entering the Minnesota River from the south between Big Stone Lake and New Ulm. These tributaries make up the following subbasin: Yellow Bank, Lac qui Parle, Yellow Medicine, Redwood, and the Big Cottonwood. Table IV-5 gives the land use in the flood plain and the total area.

Topography is flat in the lower two-thirds of the subbasins. Study results indicate the subbasins are inseparable; their problems and needs are interrelated, and a large portion of flood reduction benefits are from adjoining subbasins. Average annual damages are estimated in Table IV-6.

Many locations in Study Area II have had the unique experience of flooding from adjoining watersheds. This occurrence is referred to as "crossover flooding". Determining the amount and frequency of flood flow due to crossover flooding were of primary importance in determining possible solutions and effects on all subbasins. Each of these subbasins have interrelated flood problems that will have to be solved as a group. Attempts to solve the flooding problems individually by PL-566 watersheds have had limited success because of the interrelated flood problems.

Flooding occurs annually on some of the smaller streams. Major floods on the larger rivers occur one or two years out of ten and show the greatest frequency of occurrence in April.

Cropland flooding in Study Area II. Water was two feet deep at one stage.

Flooding of highways and roads is a major problem in Study Area II.

U. S. DEPARTMENT OF AGRICULTURE

MAJOR FLOOD DAMAGE AREAS

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE IV-2

7-7-75
5,S-34,384

SOURCE:
FAMILY OF MAPS SCS DRAWING NO. 5 S 29,422 7-15-71
AND INFORMATION FROM FIELD TECHNICIANS TRANSVERSE MERCATOR PROJECTION

TABLE IV-5. FLOOD PLAIN LAND USE[1]

Subbasins	Acres in Flood Plain	Cropland	Pasture	Woodland	Other
Yellow Bank	15,300	11,300	2,900	800	300
Lac qui Parle	97,000	62,100	21,300	7,800	5,800
Yellow Medicine	96,700	69,600	14,500	3,900	8,700
Redwood	46,400	23,200	19,500	900	2,800
Big Cottonwood	46,600	30,800	6,000	5,100	4,700
TOTAL	302,000	197,000	64,200	18,500	22,300

[1]All figures are rounded.

TABLE IV-6. AVERAGE ANNUAL DAMAGE (DOLLARS)

Subbasin	Crop and Pasture	Other Agricultural	Road and Bridge	Urban	Indirect	Total
Yellow Bank	$ 160,900	$ 18,800	$ 15,700	$ 300	$ 20,300	$ 216,000
Lac qui Parle	1,253,800	155,400	35,300	9,100	147,400	1,601,000
Yellow Medicine	1,491,300	163,400	27,800	5,700	170,800	1,859,000
Redwood	708,000	81,900	20,600	7,700[1]	82,800	901,000
Big Cottonwood	979,500	59,300	12,800	11,200	107,200	1,170,000
TOTAL	$4,593,500	$478,800	$112,200	$34,000	$528,500	$5,747,000
Percent of Total Damage	80%	8%	2%	1%	9%	100%

[1]This report assumed no urban damages in Marshall, Minnesota, because of the Corps of Engineers flood control project.

Agricultural damages along the Minnesota River Main Stem are significant throughout its length. Preliminary studies have concluded that there are considerable existing and potential damages to urban and industrial property. Agricultural land and urban areas subject to flood damages are reported in Table IV-7. Average annual damages to agricultural and urban areas are reported in Table IV-8.

F. DRAINAGE

Agriculturally, excess water becomes a problem when it interferes with land preparation, tillage, the development of plants, and harvest operation. These problems contribute to reductions in crop yield, increased production costs, and lower quality of products.

Agricultural drainage problems are caused by excess surface or subsurface water, or both. Surface drainage problems exist generally where the natural stream drainage pattern is undeveloped. In many problem areas, surface and subsurface drainage systems are interdependent.

Some soils are subject to flooding and will need flood protection to realize their full agricultural productive capacity. In some areas, channels are designed for both drainage and flood prevention. Outlets lacking sufficient capacity is a problem closely related to flood prevention. Adequate floodwater channels will ordinarily fulfill the requirements for drain outlets.

TABLE IV-7. DOWNSTREAM FLOOD PLAIN LAND USE, MINNESOTA RIVER

River Reach	Mileage	Rural Area (Acres) Total	Cropland	Pasture	Other	Urban Areas Subject to Flooding
Minnesota River						
Minn-1	0-14	9,300	4,500	3,600	1,200	Savage, Minn.
Minn-2	14-30	8,300	4,000	3,200	1,100	Shakopee and Chaska, Minn.
Minn-3	30-49	9,500	4,600	3,700	1,200	Carver and Belle Plaine, Minn.
Minn-4	49-67	6,800	3,300	2,600	900	Blakely, Minn.
Minn-5	67-90	12,200	6,500	4,200	1,500	Henderson and LeSueur, Minn.
Minn-6	90-106	6,500	3,100	2,500	900	St. Peter, Minn.
Minn-7	106-120	27,800	12,100	9,100	6,600	Mankato, No. Mankato, LeHillier, Garden City and Madelia, Minn.
Minn-8	120-147	23,000	11,500	7,200	4,300	Judson, New Ulm and Springfield, Minn.
Minn-9	147-176	9,600	4,600	3,700	1.300	
Minn-10	176-212	19,900	9,800	7,600	2,500	Morton and North Redwood, Minn.
Minn-11	212-239	22,500	14,800	5,500	2,200	
Minn-12	239-253	4,600	2,200	1,800	600	Granite Falls, Minn.
Minn-13	253-271	23,200	4,400	9,400	9,400	Montevideo, Minn.
Minn-14	271-288	4,000	1,900	1,600	500	
Minn-15	288-317	35,900	17,000	11,500	7,400	
Minn-16	317-330	8,700	4,200	3,400	1,100	Ortonville, Minn.; Big Stone City, S.D.
Minn-17	330-356	3,500	1,700	1,400	400	Ortonville, Minn.
Minn-18	356-361	3,400	1,600	1,300	500	Browns Valley, Minn.
Area Total		238,700	111,800	83,300	43,600	

TABLE IV-8. DOWNSTREAM AVERAGE ANNUAL DAMAGES, MINNESOTA RIVER

River Reach	Mileage	Total Average Annual Damage (Dollars) 1966	1980	2000	2020
Minnesota River					
Minn-1	0-14	359,500	550,000	1,272,200	1,941,900
Minn-2	14-30	479,200	756,100	1,718,400	2,618,800
Minn-3	30-49	167,600	283,600	537,000	844,400
Minn-4	49-67	111,100	186,200	335,200	521,900
Minn-5	67-90	304,300	539,500	1,007,900	1,567,400
Minn-6	90-106	148,500	248,600	470,400	740,300
Minn-7	106-120	1,053,200	1,681,400	3,743,900	5,729,400
Minn-8	120-147	335,700	566,200	1,033,800	1,650,500
Minn-9	147-176	199,800	352,300	635,400	1,450,800
Minn-10	176-212	213,000	357,800	642,600	999,700
Minn-11	212-239	221,800	368,600	660,600	1,043,500
Minn-12	239-253	66,700	111,900	205,800	315,400
Minn-13	253-271	275,100	445,900	846,100	1,306,000
Minn-14	271-288	48,300	79,600	142,600	226,100
Minn-15	288,317	220,000	365,600	648,400	986,400
Minn-16	317-330	25,700	77,300	139,300	208,800
Minn-17	330-356	40,700	64,300	147,900	225,500
Minn-18	356-361	19,700	33,400	72,700	110,400
Area Total		4,289,900	7,068,300	14,260,200	22,487,200

Drainage is needed in some areas to make some of the 4,225,700 acres of wet agricultural land more productive.

There are 4,225,700 acres of crop, pasture, forest, and other agricultural lands in the basin on which the major limitation or dominant problem is excess water. These wet soils constitute over 42 percent of all agricultural land in the basin. This percent varies by study areas, as shown in Table IV-2. Not all of this area having an excess water problem is in need of drainage. Instead, present and future drainage needs are dependent on the desired use of the areas having drainage problems. The potential economic return for the landowner will usually determine the use. Table IV-9 is an inventory of agricultural land with excess water problems in the basin.

It is estimated that 3,415,500 acres, or 81 percent, of the land with excessive water problems are utilized as cropland. There are 395,400 acres of pasture, 100,200 acres of forest land, and 314,600 acres of other agricultural land which also have excess water problems.

TABLE IV-9. INVENTORY OF AGRICULTURAL LAND WITH EXCESS WATER PROBLEMS BY CLASS-SUBCLASS[1], MINNESOTA RIVER BASIN

Item	Thousand Acres						
	IIw	IIIw	IVw	Vw	VIw	VIIIw	Total
Cropland	2,662.6	712.8	5.0	5.1	25.0	5.0	3,415.5
Pasture	161.4	133.3	6.1	21.5	67.0	6.1	395.4
Forest	35.8	8.3	0.6	7.6	45.7	2.1	100.2
Other	74.5	96.0	9.6	6.9	28.0	99.6	314.6
TOTAL	2,934.3	950.5	21.3	41.1	165.7	112.8	4,225.7

[1]From 1967 Conservation Needs Inventory.

A breakdown of the 3,415,500 acres of cropland "w" soils with a dominant problem of excess water is as follows. Some 1,115,500 acres, 33 percent, are adequately treated. This includes the 967,000 acres which had dominant drainage treatment needs plus 148,500 acres which had other dominant treatment needs, in addition to drainage needs. About 1,350,000 acres, 40 percent, have partial or inadequate drainage systems which need varying degrees of additional treatment. Some 800,000 acres, 23 percent, have a need for total drainage systems. About 150,000 acres, 4 percent, have drainage problems which are not economically, environmentally, and/or otherwise feasible to treat at present.

On farm drainage needs total nearly 2.3 million acres. This includes cropland "w" soils which need drainage and additional acres of less than well drained soils. This is the actual acreage of on-farm type drainage measures needed; however, some of these on-farm systems will be dependent upon small group or multilanduser coordination, and/or major project action for outlets at additional costs for completion of effective systems. The acreage needing small group or multilanduser coordination is estimated to be 1 million acres. The total project acreage needing major project action for outlets or to alleviate the major drainage problems is estimated to be 1.7 million acres.

Forty-five percent of the on-farm drainage needs occur in Study Area II. Twenty-two percent, 21 percent, and 12 percent of the needs occur in Study Areas I, IV, and III, respectively. Correspondingly, 40 percent of the small group needs and of the major project needs occur in Study Area II (see Figure IV-3, Drainage Need).

Generally, soils in land capability classes IIw, IIIw, and IVw, are feasible to treat for agricultural production. Presently there are 3,906,000 acres in these classes. Land in these capability classes utilized as cropland amounts to 3,380,400 acres, or nearly 87 percent. Some areas are already adequately treated while other areas have only partial or no treatment. The small portion (13 percent) being utilized as pasture, forest, and other land has very little need for drainage, unless a change in land use is desired.

Table IV-4 shows that nearly 1,969,000 acres of cropland have a dominant land treatment need of drainage systems. In addition to this land with dominant drainage treatment needs, there are considerable acreages of cropland in the basin with wet soils to a lesser extent or soils which are less than well drained which may require drainage measures in a secondary nature to other forms of land treatment.

G. WATER SUPPLY

Three percent of the total area in the Minnesota River Basin is surface water. However, little use is made of it for water supply. The availability of ground water in the Minnesota River Basin for use as a water supply is very significant and practically all cities and industries use this as a source. The location and physical properties of these water sources are discussed in detail in Chapter II of this report. A ground water distribution map is displayed as Figure II-9.

1. Urban

There are 149 local public water supply systems in the Minnesota River Basin. These systems obtain their water supply from wells, with the exception of two – Fairmont and Granite Falls. Budd Lake is the source of water for Fairmont, while Granite Falls pumps its water from the Minnesota River. Wells of 150 feet to 500 feet in depth generally provide an adequate source for the other communities. Municipal water withdrawals are projected to increase from 17 million gallons per day (mgd) – 0.7 mgd from surface water – in 1960 to 73 mgd in 2020. While industrial withdrawals are projected to increase from 34 mgd to 256 mgd over this same period.

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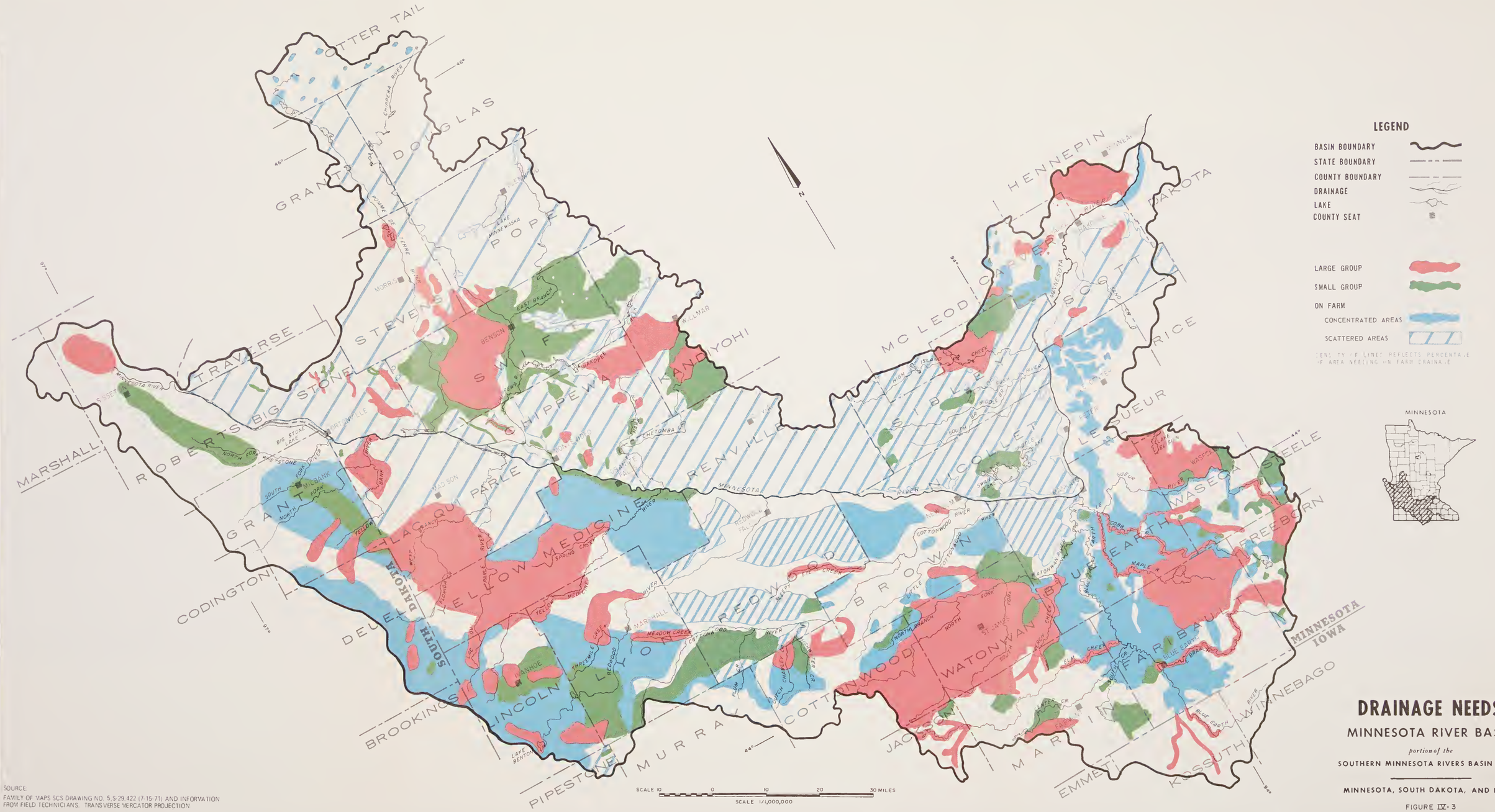

LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- COUNTY SEAT

- LARGE GROUP
- SMALL GROUP
- ON FARM
  - CONCENTRATED AREAS
  - SCATTERED AREAS

DENSITY OF LINES REFLECTS PERCENTAGE OF AREA NEEDING ON FARM DRAINAGE

DRAINAGE NEEDS

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE IV-3

7-7-75
5,S-35,275

SOURCE:
FAMILY OF MAPS SCS DRAWING NO. 5,S-29,422 (7-15-71) AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION

USDA SCS LINCOLN, NEBR. 1975

Study questionnaires indicated no significant water supply problem in the basin. Some of the 58 communities surveyed by the Department of Economic Development, however, did note inadequate facilities and distribution systems. The peak water demand nearly equals or exceeds pumping capacity in Fairfax, LeSueur, New Ulm, and Marshall. The remaining communities, from which profiles were available, had pumping capacity at least 25 percent in excess of peak demand.

In general, no municipal water supply shortages exist and few are anticipated with projected growth. Additional water supply will be required by 2000 in Mankato, Minnesota. This area's municipal and industrial needs might be satisfied by using water from the Minnesota River. Three areas having a need for additional supply by 2020 are Fairmont, Marshall and New Ulm, Minnesota. The communities of Fairmont and Marshall can probably meet their future needs through development of local impoundments and/or recharging of the ground water supply. New Ulm can probably obtain an additional supply from the Minnesota River.

The chemical quality of the ground water from the aquifers in the Minnesota River Basin is generally good, although in some areas hardness is moderate or extreme, with excessive amounts of iron and manganese. High sulfates are present in the ground water throughout the basin. These problems can be overcome by adequate treatment of water supplies at the community level. Water quality testing of all new wells and periodic sampling of existing wells is recommended. Currently a number of counties are forming water districts for a better supply and improved quality.

2. Agriculture

Currently irrigation is not extensively practiced in the basin. In 1970, gross water requirements for irrigation were 1,130 acre feet. To satisfy economic potential for irrigation in 2020, it is projected that 515,000 acre feet of water will be required. In addition, water withdrawals for livestock and rural domestic uses are projected to increase from 35 mgd in 1960 to 100 mgd in 2020. A portion of this requirement for livestock water is provided by dugouts and ponds.

Sprinkler irrigation provides water for crops during dry years.

USGS is continuing to conduct ground water studies to determine irrigation potential in the Minnesota River Basin. The Bonanza Valley Area Ground Water Study in Pope County has been completed, and the Lake Emily (Pope County) and Pomme De Terre Sands (Big Stone, Chippewa, and Grant Counties) ground water studies are in progress. Although ground water supply in the basin is presently adequate, the projected demand for 460 mgd of irrigation water by 2020 is significant, and additional ground water studies must be completed before an accurate assessment can be made. However, useful conclusions can be made as to which areas irrigation is probably not feasible.

The areas shown in red and yellow on the Ground Water Distribution Map (Figure II-9) generally would not support irrigation developments from on-site ground water supplies. Irrigation in these areas would require large scale development with water being supplied from large water impoundments or importation.

H. FOREST LAND PROBLEMS

The lack of proper forest management is the major problem affecting forest land within the basin (see Table IV-4, Conservation Treatment Needs). Poor management practice is the result, primarily, of economic conditions; there are few wood-using industries in the region, and thus the demand (market price) for timber is insufficient to encourage management. Because of this neglect, disease, fire, and grazing have become specific problems in certain areas.

1. Disease

Dutch elm disease (DED) is the most serious threat to the basin's limited forest resource, which is 39 percent elm.[1] The disease was first observed in the basin about 1967 in the eastern and southern reaches. By 1974 it had spread throughout the basin.

The DED problem must be addressed if the present character of the forest is to be maintained. Without action, by the year 2000, essentially all the existing elm will be gone and the residual stand will be limited to those individuals less than 6 inches in diameter where natural immunity is active. With continued growth these, too, will die, and by 2020 only ornamental elm will remain.

Control of DED is extremely expensive because there is no effective large-scale treatment of the disease. Each tree must be treated separately, and efforts are therefore generally confined to highly valued ornamentals. In view of this, the only recourse the landowner has is to remove and utilize infected trees as soon as possible after detection. This will not eliminate DED, nor will it preserve indefinitely the character of the basin's forests. It will, however, slow its rate of spread, and may provide the time necessary to devise an effective means of control.

2. Fire

Fire is also a problem affecting the forest, though its impact is not as severe as that of DED. Approximately fifty fires occur each year causing a total burn of 3,000 acres annually. This is well within the annual acceptable fire loss limit.

Little permanent damage is done to the forest by these fires because they are seldom hot enough to kill or even seriously weaken the trees. However, even the smallest fires destroy valuable wildlife habitat and increase erosion and sediment volumes, and therefore should be eliminated.

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[1] A Third Look at Minnesota's Timber, 1971. Elm is a major component of the lowland hardwood type.

To control this problem, the public must be educated. Both the farmer who is converting idle or brush land to production, and the hunter who is driving game out of the forest, must be shown the consequences of fire.

3. Grazing

Grazing is a serious forest management problem within the basin for two reasons: (1) it is widespread; and (2) it impairs the growth potential of the forest itself. The animals harm the site by causing severe soil compaction, and by disturbing the soils protective litter cover. As a result, infiltration and percolation rates decrease, runoff and erosion volumes increase, nutrients are lost, and site productivity declines.

An extensive survey of grazed forest land in the basin was conducted to determine the seriousness of the erosion-sediment problem. On 106 plots of varying slopes and grazing intensities, erosion and sediment volumes were estimated. The results of the survey, as shown in Figures IV-4 and IV-5, indicate that erosion and sediment volumes increase steadily with the percent slope and grazing intensity, and that grazing of slopes over 40 percent causes severe soil loss problems. (Table IV-10 lists the grazing intensity descriptions as used in the survey.)

It is also interesting to note in Figure IV-5 that sediment and erosion volumes are approaching equality. This indicates the effect grazing has on the site. Often the streamside buffer of brush and annuals is disturbed, and the deposition of suspended soil occurs directly within the channel.

4. Market Structure

To solve these management problems will be difficult, in view of the poor market potential for forest products. The industry demand for wood material in the region is not expected to increase significantly in the future, and thus the impetus for improved management must come from educational programs, and from the expenditure of funds from other programs. For instance, the installation of good forest management practices could conceivably be a condition for on-farm assistance under the Agricultural Conservation Program or other federal or state cooperative programs.

I. POLLUTION

In response to the nation's need and desire to improve the environment, Congress enacted the Federal Water Pollution Control Act Amendment of 1972. These amendments established a national goal of achieving water quality adequate to allow fishing and swimming in all of the nation's surface waters by 1983. The Minnesota Pollution Control Agency has responsibility for determining the best current uses to which the state's waters may be put, and the quality of the waters necessary to meet these uses.

Soils throughout the Minnesota River Basin are considered highly fertile consisting of sandy to clay-type loams and tills. Many of these soils are highly susceptible to water and wind erosion. Both erosional types contribute significantly to nonpoint source pollution problems.

Many of the lakes within the basin are shallow, warm, and turbid, and are extremely susceptible to eutrophication. These lakes have high phosphorous, nitrogen, and alkalinity levels. The most probably source of these nutrients is overland runoff across erodible soils. Surface runoff from agricultural fields carry with it great amounts of sediment, nitrogen, and phosphorus, all of which accelerate lake eutrophication. Commercial fertilizers (a source of nutrient pollutents) purchased by Minnesota River Basin farmers in 1969 amounted to $2,147 per square mile, as compared to the state average of $1,027, and has resulted in increased lake eutrophication in some areas and the pollution of lakes and streams. That same year, basin farmers spent an average of $856 per square mile for nonfertilizer chemicals, as compared to a state average of $326.

A number of the lakes have seasonal residences along their shores. Blue Earth, Big Stone, Sibley, and Nicollet Counties have from 10-40 seasonal homes per square mile of surface water. Kandiyohi County has 40 or more seasonal homes per square mile of surface water. The septic tank effluent from these residences is partially responsible for the pollution of lakes within the basin.

Seven lakes have been examined as part of the U.S. Environmental Protection Agency National Eutrophication Survey. They are: Big Stone Lake in Big Stone County; Lilly Lake and Madison Lake in Blue Earth County; Little Lake in Grant County; Budd Lake in Martin County; and Malmedal Lake and Lake Minnewaska in Pope County. The results of these surveys have been published in the Minnesota River Basin, *Water Quality Management Basin Plan* prepared by the Minnesota Pollution Control Agency, Division of Water Quality. This report was published June 1975 and is distributed by the Documents Section, Department of Administration, Centennial Building, St. Paul, Minnesota.

This survey indicates that in addition to surface runoff, a number of lakes in the basin are affected by municipal and industrial pollutants. It is essential that these point sources implement stringent waste water treatment practices (including phosphorus removal) to prevent accelerated eutrophication in these already nutrient loaded lakes. Municipal and industrial point sources of pollution currently have the highest priority and are required to provide best practicable treatment by July 1, 1977.

Inspection of census data from 1960 to 1970 for the Minnesota River Basin reveals a number of trends that will have a direct effect on point source water pollution potential in the basin. Although the population of the basin as a whole has declined slightly, population of the following counties has increased: Blue Earth, Brown, Kandiyohi, LeSueur, Lyon, Nicollet, Rice, and Stevens. These counties, especially Blue Earth and LeSueur, can anticipate increased water pollution problems – either from overloading of existing treatment systems, or residence construction in areas affecting streams and lakes and having no treatment systems.

The Minnesota Pollution Control Agency has determined that, of the 133 communities in the Minnesota River Basin; 29 currently provide adequate treatment, 25 are expected to be able to provide adequate treatment by making various operational or maintenance improvement on the existing facilities, 60 must upgrade or replace their current facilities, and 19 currently have no facilities (other than private septic tanks).

They further determined that of the 46 industrial dischargers in the basin, 13 now provide adequate treatment, while 33 are currently inadequate.[1]

A more perplexing problem is that of nonpoint sources of pollution. The extent of actual nonpoint source pollution depends on natural conditions and control measures, or lack of such, associated with such land uses as tillage, chemical applications, livestock containment, and construction.

Lack of proper land treatment practices has resulted in increased pollution in the basin.

Livestock numbers in the basin have been relatively stable since 1960. The Minnesota Crop and Livestock Reporting Service reported 1.3 million head of cattle and calves on farms in 1974 – only 4 percent less than reported in 1960. An inventory of 1.8 million hogs and 100,000 sheep is also reported.

Although total livestock numbers have not changed significantly, new technology and management practices have led to significant changes in their concentration. The general trend of larger and more concentrated feeding areas has resulted. With this trend has grown the concern of environmental effect on surrounding areas and water resources.

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[1]Water Quality Management Basin Plan, Minnesota River Basin, Minnesota Pollution Control Agency, June 1975.

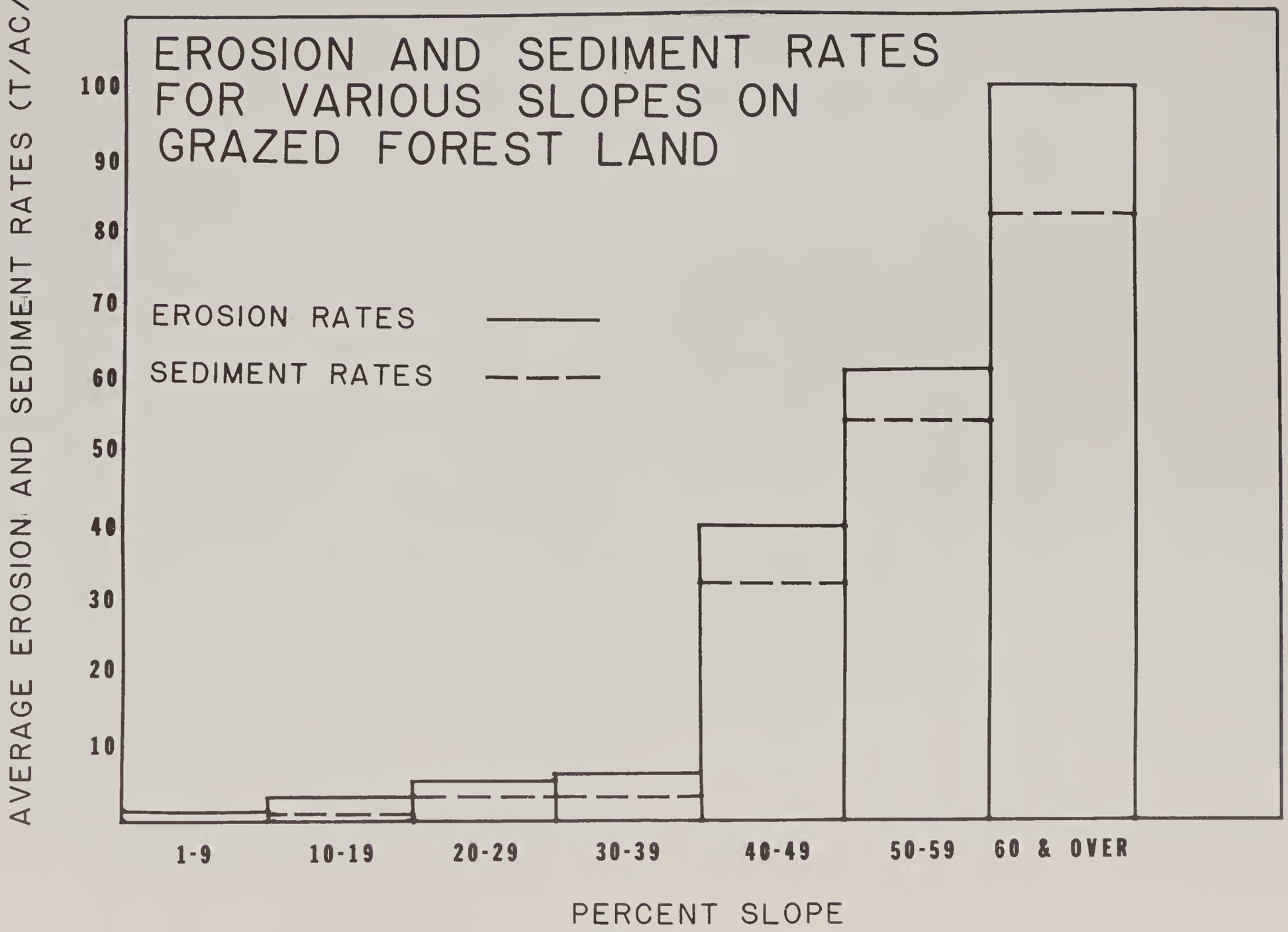

EROSION AND SEDIMENT RATES
FOR VARIOUS SLOPES ON
GRAZED FOREST LAND
EROSION RATES
SEDIMENT RATES
AVERAGE EROSION AND SEDIMENT RATES (T/AC/YR)
100
90
80
70
60
50
40
30
20
10
1-9
10-19
20-29
30-39
40-49
50-59
60 & OVER
PERCENT SLOPE

FIGURE IV-4

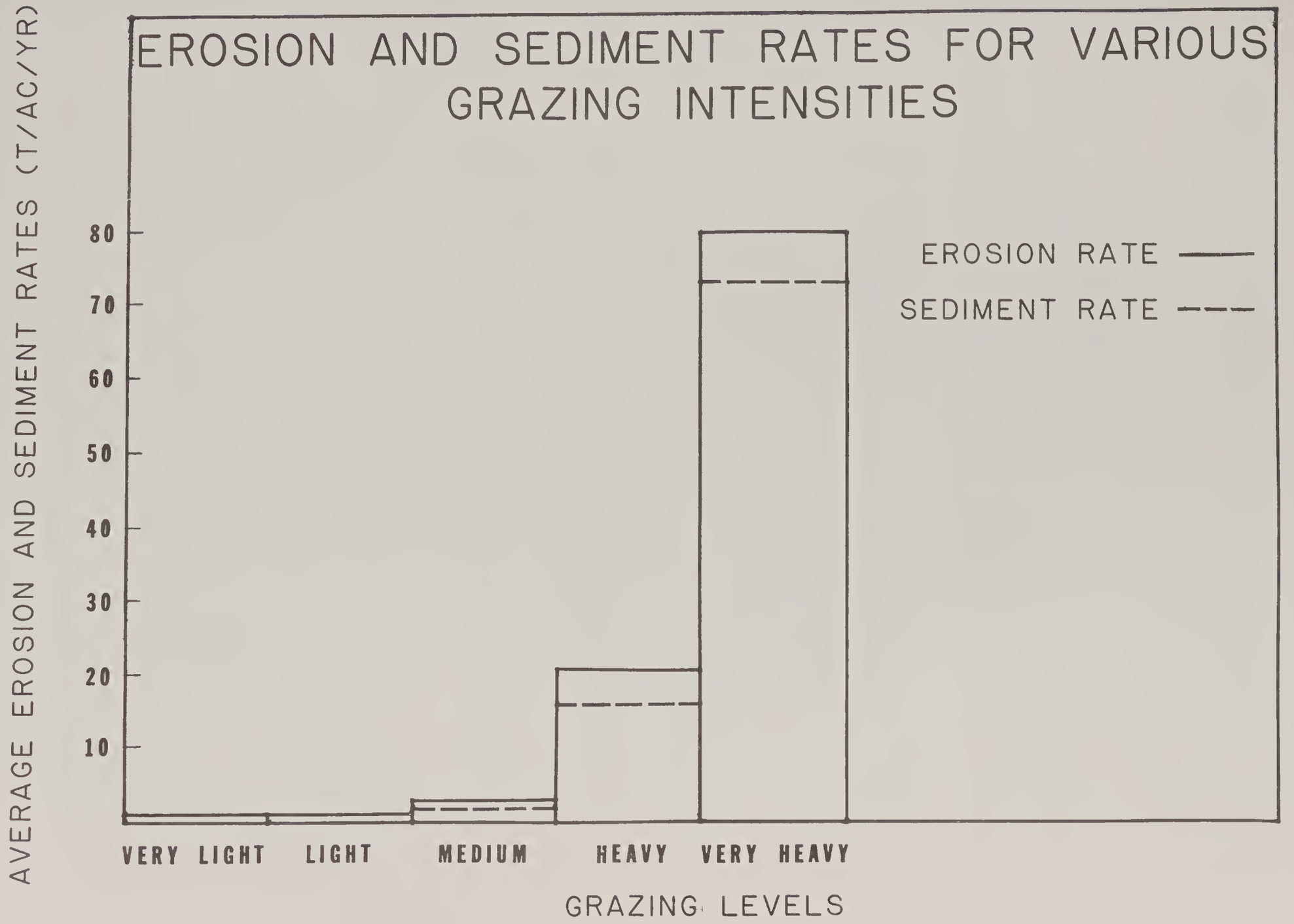

EROSION AND SEDIMENT RATES FOR VARIOUS GRAZING INTENSITIES
AVERAGE EROSION AND SEDIMENT RATES (T/AC/YR)
80
70
60
50
40
30
20
10
EROSION RATE
SEDIMENT RATE
VERY LIGHT
LIGHT
MEDIUM
HEAVY
VERY HEAVY
GRAZING LEVELS

FIGURE IV-5

TABLE IV-10. GRAZING INTENSITY CHARACTERISTICS

Grazing Intensity	Percent Bare Ground	Characteristic	
		Amount and Type of Cattle Trails	Forest Litter Condition
Very Light	0-5	Very few, if any, travel trails	Disturbed, but not replaced by weeds
Light	6-10	A few travel trails, no grazing trails[1]	Disturbed, but not replaced by weeds
Medium	11-25	Moderate number of travel and grazing trails	Disturbed, weeds starting to invade the sites
Heavy	26-69	Numerous travel and grazing trails	Disturbed, weeds starting to dominate the site understory
Very Heavy	70+	Hard to tell where grazed areas and trails begin to end	Almost destroyed, weeds dominate the site

[1]Cross trails between travel trails.

In an attempt to indicate the level of concentration in the basin, the number of feedlots and number of cattle by feedlot size were estimated. Using 1969 Agricultural Census and Statistical Reporting Service Data, 413,000 head were being fed on the basin's 8,526 feedlots (Table IV-11). Approximately 7.5 percent of fed beef were in 19 feedlots with over 1,000 head. Another 15 percent were fed in feedlots of 500-1,000 head each. The remaining 77 percent of the basin's fed beef were grown in smaller feedlots not exceeding 500 head.

A number of feedlots are located in areas with direct accessibility to surface waters. In many areas, pastures utilized for livestock production are undesirable, as livestock have direct access to streams and lakes. The Minnesota Pollution Control Agency found that pollution potential from livestock production in the basin is high.

TABLE IV-11. NUMBER OF FEEDLOTS BY SIZE AND CATTLE ON FEED BY FEEDLOT SIZE, MINNESOTA RIVER BASIN, 1969

	Study Area I	Study Area II	Study Area III	Study Area IV	Total
Number of Feedlots by Feedlot Size					
Less than 100 head	1,372	2,881	1,554	1,590	7,397
100-199 head	128	309	113	99	649
200-499 head	74	175	86	43	378
500-999 head	18	35	22	8	83
Over 1,000 head	11	5	2	1	19
TOTAL	1,603	3,405	1,777	1,741	8,526
Number of Cattle on Feed by Feedlot Size					
Less than 100 head	19,854	50,653	28,320	19,371	118,198
100-199 head	17,980	42,111	15,246	13,361	88,698
200-499 head	21,636	49,568	25,663	16,306	113,173
500-999 head	13,539	24,127	17,957	6,711	62,334
Over 1,000 head	17,272	7,888	3,206	2,474	30,840
TOTAL	90,281	174,347	90,392	58,223	413,243

A study of the Minnesota portion of the basin revealed that 8,503 livestock enterprises are potential nonpoint sources of pollution. See Table IV-12 for a detailed list by county and study area. In the future, as municipal and industrial point source effluents are improved and point source impacts are determined through increased monitoring, it will become even more evident what the nonpoint source affects on streams are.

TABLE IV-12. NUMBER OF LIVESTOCK ENTERPRISES THAT ARE POTENTIAL NONPOINT SOURCES OF POLLUTION, BY COUNTY AND STUDY AREAS[1]

County	Total in Basin	Study Area I	Study Area II	Study Area III	Study Area IV
Big Stone	147			147	
Blue Earth	259	197	45		17
Brown	530	51	479		
Carver	497				497
Chippewa	180			110	70
Cottonwood	180	72			108
Dakota	38				38
Douglas	388			388	
Faribault	210	210			
Freeborn	108	108			
Grant	66			66	
Hennepin	54				54
Jackson	32	32			
Kandiyohi	317			107	210
Lac qui Parle	290		285		5
LeSueur	294	2			292
Lincoln	245		245		
Lyon	254		254		
McLeod	125				125
Martin	206	206			
Murray	74		74		
Nicollet	380				380
Otter Tail	188			188	
Pipestone	18		18		
Pope	439			439	
Redwood	330		330		
Renville	281				281
Rice	65				65
Scott	422				422
Sibley	731				731
Steele	54	54			
Stevens	109			109	
Swift	240			240	
Traverse	7			7	
Waseca	275	275			
Watonwan	200	200			
Yellow Medicine	270		270		
TOTALS	8,503	1,407	2,000	1,801	3,295

[1]Does not include counties in South Dakota and Iowa.

J. FISH AND WILDLIFE

The major problems for wildlife within the basin are continued loss of habitat to other land uses and deteriorating quality of remaining habitat acres. These problems result from increased demands on land and water resources, primarily for agricultural production and urban expansion.

The major losses of woodland are to recreation, country home sites, and expanded crop production. The loss of woodlots, windbreaks, and brush cover between and within fields is the most detrimental to woodland wildlife species. These losses eliminate vast acres of food producing cropland from use by these species which must have protective cover near their food sources. As a result, animals are forced to concentrate on lands bordering the wooded river bottoms where cover is available.

Woodland habitat quality suffers from overgrazing, inadequate ground cover, improper distribution, and stand maturity. Most of the present windbreaks are single row and lack coniferous species. Although these windbreaks provide travel lanes, they do not provide adequate protection from winter storms or predators.

There is a need to determine population levels of woodland wildlife which would be desirable and compatible with agricultural production within the basin. Incentives are needed to encourage private landowners to retain and improve their woodlots and windbreaks, and to manage woodlands for wildlife. Multi-row windbreaks and small block plantings of trees and shrubs are needed in the heavily cropped portions of the basin to replace past and current losses, and to provide a better distribution of woodland acres.

As a part of Phase II studies in Study Area II, research studies by the Minnesota Department of Natural Resources (MDNR) and other supporting data were reviewed and summarized to determine contributing factors for the downward trend of pheasant populations.

Problems and needs of pheasant habitat are similar to those of most upland species and, thus, are presented as being representative for the upland wildlife group.

Land use trends, predation, and climatic conditions were cited as the major factors involved in the declining pheasant population in the Study Area II analysis. It concluded that shifting land use was the major impact, in that less cover was available for protection from predation and severe weather.

Considerable natural cover has been lost to agricultural uses, including residual herbacous cover once found along fencelines, borders, ditches, and odd corners. The departure from crop rotation systems to continuous row cropping has drastically reduced the quantity of small grain acres available for nesting habitat (Figure IV-6). Pasture and hayland acres have steadily declined as well. While lightly grazed pasture provides good nesting cover, most remaining pastureland within the basin is moderately to heavily grazed. Legume hay also attracts nesting birds. However, since hay is mowed early in June, nest failure is high and many hens and chicks are killed or injured during mowing. These combined losses of "safe" nesting habitat are cited as primary factors in the decline of pheasant numbers (Figure IV-7).

Although corn and soybeans are major food items in the pheasant's diet and abundant supplies are an asset, the availability of waste grain in winter is largely determined by the amount of fall plowing and snow depth which remains over winter. Virtually all the row crop acres are fall plowed, thus precluding those acres from use for winter food or cover. The continued loss of woodlots, windbreaks, and brush cover discussed in the woodland section of this chapter, has also seriously reduced the availability of winter and escape cover for pheasants and other upland species.

The major needs for upland wildlife habitat per section are: 50-75 acres of undisturbed grass or legume cover, at least one stand of dense coniferous and low deciduous tree cover of 1-15 acres, and standing food plots of 1-3 acres near established winter cover. Greater use of soil suitability information should be made in land use decisions. Many areas of rough, rolling land with complex slopes are better suited for grassland, hay, or pasture, than for grain crop production. Programs which emphasize such land treatment practices as crop rotations, minimum tillage, critical area plantings, farmstead and field windbreaks, woodland management, pasture management, and delayed mowing of herbaceous cover until after nesting

A productive wetland area.

season should be implemented and properly funded. Strict enforcement of regulations prohibiting mowing and burning of road ditches and county ditchbanks, as well as managing those areas as upland habitat, is needed.

Wetland habitat in the Minnesota River Basin continues to decline. The major problem lies in the inherent conflict with agricultural drainage needs. Wetlands which keep groundwater levels high or restrict surface drainage tend to reduce production on surrounding croplands. Although this conflict has existed since early settlement of the basin, recent increases in production costs and national emphasis on all-out crop production have greatly intensified the problem. Many Type I, II, and III wetlands are cropped whenever dry conditions exist. Where Types III, IV, and V wetlands remain intact, surrounding nesting habitat is generally lacking due to overgrazing, burning, or encroachment by croplands. Eutrophication and sedimentation have accelerated the evolution of many wetlands to more shallow, drier types.

The need for wetland preservation is indicated by the priority placed on the region by state and federal acquisition programs. Acceleration of these programs is needed. The greater need, however, is to provide incentives to private landowners to retain and manage their wetland acres as wildlife habitat. Approximately 70 percent of the remaining wetland resources in the basin are privately owned. Without the support and cooperation of private landowners, attempts to preserve those wetlands will fail. Positive economic incentives for private wetlands preservation are needed at all governmental levels. An intense information and education program, outlining the geologic and climatic uniqueness of the prairie pothole region and its resulting national importance as a major waterfowl production area, is needed.

Properly funded programs emphasizing wetland management, wetland improvement, farm ponds, wildlife dugouts and pits, pasture management, and establishment of herbaceous cover with delayed mowing is needed. For nesting cover, undisturbed grassy or herbaceous vegetation is needed within one-quarter mile of a wetland, and on a ratio of 1:1 with wetland acres.

FIGURE IV-6

TRENDS IN AGRICULTURAL LAND USE IN RELATION TO PHEASANT NESTING HABITAT

1948–1971

MINNESOTA RIVER BASIN

(AREA II)

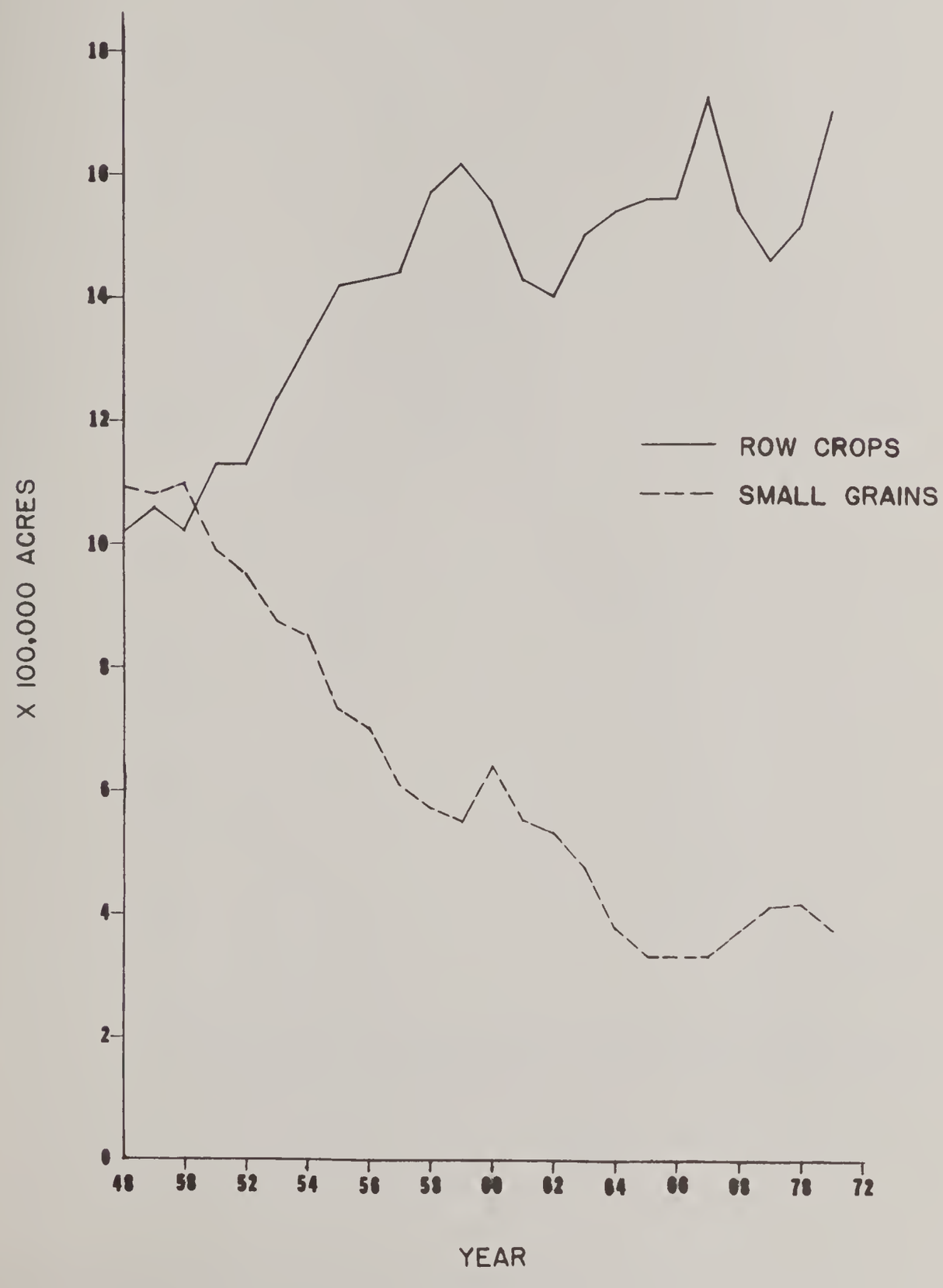
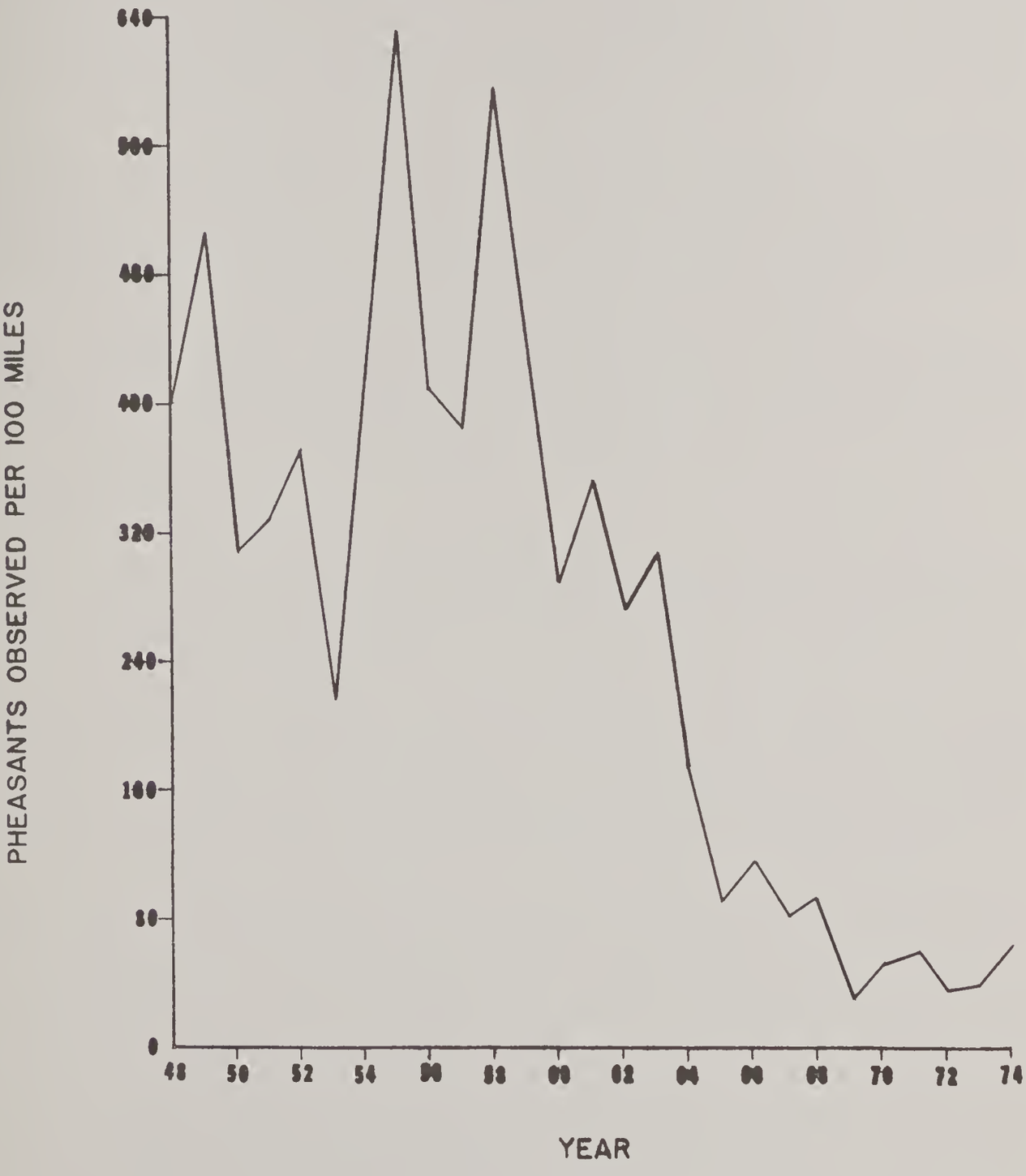


FIGURE IV-7

AVERAGE AUGUST ROADSIDE PHEASANT COUNT

MINNESOTA RIVER BASIN
(AREA II)

1948-1974



The Minnesota River Basin is oriented toward agricultural production and will remain so in the future. The acres of land available to provide adequate habitat for wildlife are limited, and, thus multiple use of those acres by a variety of species is imperative. While discussed separately in this chapter, the needs of the various species of wildlife are interrelated and interdependent. The main objective of wildlife habitat improvement should be establishment of vegetative diversity. Such diversity should provide stratification from groundcover (grass) to overstory (trees), and be distributed in a manner which maximizes "fringe" with other vegetative types. These patterns of interspersed vegetation can only be achieved with full cooperation between wildlife agencies and private landowners who control the majority of land, and thus, the ultimate fate of the basin's wildlife resources.

The basin's fishing waters share two common problems – sedimentation and rough fish invasion. Removal of shoreline and streambank vegetation by grazing, development, and other causes has not only created erosion problems, but has reduced spawning habitat and protective shaded areas. Erosion from croplands carries pesticides and nutrients, as well as silt, into most of the lakes which compound the winterkill and eutrophication problems inherent to the region. Siltation is a major problem in the rivers and streams. Carp and other rough fish problems are nearly universal. While total production of fish generally increases in carp infested waters, it is usually at the expense of game fish.

Such land treatment practices as terraces, grassed waterways, sediment basins, minimum tillage, and pasture management are needed to reduce erosion rates to proper levels. Re-establishment of undisturbed streambank and shoreline vegetation is needed to provide filtration of runoff into lakes and streams, shade cover for fish, and erosion stabilization on streambanks and shorelines. Stream improvement practices, such as creation of waterfalls, riffles and pools, and vegetated overhand banks, are needed in many streams.

Increased funding for rough fish control is needed. Chemical treatment and restocking of lakes, seining and netting, and construction of fish traps and barriers are methods which can be employed to help control rough fish. Aeration systems are needed for some game-fish lakes which experience winterkill problems, due to oxygen depletion.

K. RECREATION

The demand for outdoor recreation opportunities has steadily increased in the past two decades. Measuring that demand accurately and predicting future needs is a difficult task. Changes in economic conditions, population, leisure time, and especially user attitudes can produce wide variations in activity levels.

Current methodology is a problem in itself. Basic data concerning actual use of facilities by the public is often not available, due primarily to insufficient funding for user surveys. Spacial standards for the different activities are not universally accepted. These standards usually vary by planning agency and from region to region. No satisfactory method is available to evaluate quality of recreation experience in quantitative terms for planning use. A better understanding of man's need for recreation and his expectations from it is needed.

Projected future levels of participation in recreation activities within the basin and the resulting resource requirements are listed in Tables IV-13 and IV-14. Water-based activities are not equally available within the basin. There is a large disparity between lake acres and associated facilities between study areas. Present resources in Study Area III far exceed present and future needs, while large deficiencies in lake acres are projected in Areas I, II, and IV (Table IV-15). Problems with depth, sediment, eutrophication, and water quality restrict the use of many lakes for recreation purposes. Conflicts between incompatible activities such as waterskiing and boat fishing are also common. There is a need for cooperative basin-wide lake surveys to identify those which can feasibly be improved by dredging, increased outlet elevations, upstream sediment traps, and other improvement practices. Suitability groupings for lake associated activities could then be determined, and recommendations for proper use

TABLE IV-13. PROJECTED OUTDOOR RECREATION ACTIVITY OCCASIONS EXPECTED TO OCCUR ON AN AVERAGE WEEKEND DAY – YEAR 2000, MINNESOTA RIVER BASIN

Activity	Study Area I	Study Area II	Study Area III	Study Area IV	Basin TOTALS
Swimming	59,173	44,669	21,937	90,092	215,871
Playing Golf	6,693	5,053	2,481	10,191	24,418
Playing Tennis	6,833	5,158	2,533	10,404	24,928
Playing Outdoor Games	104,407	78,815	38,706	158,960	380,888
Walking for Pleasure	14,874	11,228	5,514	22,646	54,262
Bicycling	72,017	54,365	26,698	109,646	262,726
Horseback Riding	3,814	2,879	1,414	5,807	13,914
Trap and Target Shooting	1,112	840	412	1,694	4,058
Fishing	12,079	11,836	8,129	19,308	51,352
Boating	3,832	3,755	2,579	6,126	16,292
Canoeing	3,494	3,424	2,351	5,585	14,854
Water Skiing	18,303	17,751	12,316	29,258	77,628
Sailing	618	607	418	990	2,633
Camping	19,145	18,761	12,883	30,605	81,394
Hiking	912	894	614	1,457	3,877
Picnicking	18,834	18,456	12,675	30,107	80,072
Nature Walks	20,227	19,820	13,610	32,333	85,990
Snowmobiling	15,650	15,336	10,532	25,018	66,536
Snow Skiing	728	713	490	1,163	3,094
Small Game Hunting	6,203	5,198	3,507	9,253	24,161
Large Game Hunting	15,281	14,953	8,076	22,565	60,875
Waterfowl Hunting	4,753	3,343	1,922	6,987	17,005

TABLE IV-14. RESOURCES NECESSARY TO PROVIDE FUTURE (YEAR 2000) RECREATION LEVELS WITH ACCEPTABLE SPACE STANDARDS*, MINNESOTA RIVER BASIN

Activity	Study Area I	Study Area II	Study Area III	Study Area IV	TOTALS
Swimming Beach					
Water (Acres)	20.0	15.1	7.4	30.4	72.9
Land (Acres)	100.0	75.5	37.0	152.2	364.7
Pools (1000 ft.^{2})	665.7	502.5	246.8	1,013.5	2,428.5
Golfing (Rounded to even 9 hole course)					
Holes	216	162	81	324	765
Acres	2,160	1,620	810	3,240	7,650
Tennis (Courts)	214	161	79	325	779
Outdoor Game Fields (Acres)	1,198.4	904.7	444.3	1,824.6	4,372
Trap and Target Shooting (Acres)	556.0	420	206	847	2,029
Fishing – Water (Acres)	27,178	26,631	18,290	43,443	115,542
Boating – Water (Acres)	5,109	5,007	3,439	8,168	21,723
Canoeing – Stream (Miles)	218.4	214	147	349	928.4
Water Skiing – Water (Acres)	45,758	44,378	30,790	73,145	194,070
Sailing – Water (Acres)	824	809	557	1,320	3,511
Camping – Sites	9,117	8,934	6,135	14,574	38,760
Camping Acres					
Developed	957.3	938.1	644.2	1,530.3	4,069.9
Support	4,786	4,690	3,221	7,651	20,349
Hiking Trails	18.2	17.9	12.3	29.1	77.5
Picnicking Tables	3,139	3,076	2,113	5,018	13,345
Picnicking Acres					
Developed	627.8	615.2	422.5	1,003.6	2,669.1
Support	3,139	3,076	2,113	5,018	13,345
Nature Trails (Miles)	404.5	396.4	272.2	646.7	1,719.8
Snowmobile Trails (Miles)	521.7	511.2	351.1	833.9	2,217.9
Hunting Small Game (Upland Acres)	49,624	41,584	28,056	74,024	193,288
Hunting Large Game (Upland Acres)	977,984	956,992	516,864	1,444,160	3,896,000
Hunting Waterfowl (Wetland Acres)	21,389	15,044	8,649	31,442	76,523

*Standards not available for bicycling, horseback riding, or walking for pleasure. Acres for large game hunting are based on a two day season, which has been established in the MRB area in recent years.

TABLE IV-15. OUTDOOR RECREATION FACILITY NEEDS, MINNESOTA RIVER BASIN, 1975 AND YEAR 2000

Facilities Required – 1975 Supply = deficiency (–) or surplus (+)

	Study Area I		Study Area II		Study Area III		Study Area IV		Basin TOTALS	
	1975	2000	1975	2000	1975	2000	1975	2000	1975	2000
Swimming Beach										
Water (Acres)	–5.6	–10.8	–1.0	–2.7	+20.4	+21.7	+6.0	–7.3	+19.4	+0
Land (Acres)	–69.7	–95.6	–63.0	–71.6	–3.0	+3.3	–59.5	–126.4	–195.2	–290
Pools (1000 ft.^{2})	–465.0	–637.3	–381.6	–438.6	–267.4	–226.1	–485.9	–931.3	–1600.0	–2233
Golfing (Rounded to even 9 hole course)										
Holes	–18	–81	–	–18	–36	–27	+252	+108	+198	–
Acres	–564.0	–1,194.0	–430.0	–610.0	–562.0	–472.0	+878.0	–653.0	–769.0	–2,749
Tennis Courts (No.)	–35	–149	–42	–112	–18	–38	+108	–101	+13	–400
Outdoor Game Fields (Acres)	–359.6	–691.4	–487.5	–609.7	–202.1	–600.7	+854.1	+27.4	–195.1	–1414
Fishing Water (Acres)	–3738	–9,705	–979	–5,693	+73,781	+71,376	+1,943	–13,213	+71,007	+42,765
Total Recreation Water (Acres)	–12,380	–42,881	–13,837	–40,682	+98,757	+81,904	+2,674	–58,896	+75,114	–60,555
Camping – Sites	–1,090	–3,968	–1,484	–4,202	–415	–2,207	–2,166	–7,272	–5,155	–17,560
Camping – Developed (Acres)	–343.9	–919.5	–331.3	–875.0	–178.2	–536.6	–452.0	–1,473.3	–1,305.4	–3,804
Picnicking – Tables	–1,269	–2,204	–1,417	–2,221	–439	–902	–886	–2,965	–4,011	–8,291
Picnicking – Developed (Acres)	–400.8	–587.9	–411.9	–572.7	–263.1	–355.5	–413	–1,178.4	–1,488.8	–2,344
Hiking Trails (Miles)	+0.6	–1.2	+24.1	+23.1	+31.8	+31.7	+108.2	+100.9	+164.7	+154
Nature Trails (Miles)	–320.4	–404	–318.5	–383.4	–230.3	–262.2	–403.2	–622	–1,272.4	–1,671
Snowmobile Trails (Miles)	–457.9	–511.7	–447.5	–475.2	–309.4	–310.1	–558.1	–767.9	–1,772.9	–2,064
Hunting Small Game (Upland Acres)	–34,963	–42,483	–10,216	–9,944	+62,729	+70,489	–48,700	–68,884	–31,150	–50,822
Hunting Waterfowl (Wetland Acres)	–11,765	–17,678	–1,569	–885	+30,807	+33,417	–17,666	–28,835	–193	–13,980

or uses of the lakes could be made. Most water enhanced and land based facilities are deficient basin wide, and some represent important priorities for additional development. Developed miles of nature trails are less than 10 percent of future needs. Snowmobile trails and developed acres for picnicking and camping represent less than 20 percent of those needed by year 2000 (Table IV-16).

Public access to the various facilities is a key factor to the utilization of recreation resources. The major needs for increased public access are to lakes and streams, and to private lands for hunting. Many of the more popular lakes will continue to be overcrowded until demands are redistributed to areas not presently accessible or are now underutilized. Problems of hunter and recreationist abuse of privileges have closed much of the private land from public access. Although Study Area III has sufficient acres of public hunting lands to meet its needs for small game and waterfowl hunting, the entire basin must depend upon private lands for large game hunting, and a large share of small game and waterfowl hunting in Areas I and IV. Stream fishing and canoeing also require some access to private lands. Thus, there is a need for cooperative programs which emphasize user responsibilities, and also provide incentives to landowners to allow public use of their land for hunting and other activities.

Hunting activity fluctuates with supplies of game, hunter density, established seasons, bag limits, and weather conditions. The problems and needs for supplying adequate numbers of game species are discussed in the wildlife section of this chapter. If woodland habitat was redistributed, this would also relieve the hunter density problems created in concentrated areas by a two day deer season. Not only can local herds be overharvested by this type of season, but many hunters do not fully enjoy the experience and resulting safety problems that are created. Hunting, as a socially acceptable form of outdoor recreation, has become a controversial issue in recent years. There is a need for all segments of society to fully understand the implications of this issue, both upon wildlife populations and management, and upon hunters and nonhunters alike. Greater emphasis on nonconsumptive uses of wildlife, such as

TABLE IV-16. DEVELOPMENT PRIORITIES*, OUTDOOR RECREATION FACILITIES, MINNESOTA RIVER BASIN

	Study Area I		Study Area II		Study Area III		Study Area IV	
	1975	2000	1975	2000	1975	2000	1975	2000
Swimming Beach								
Water	7	5	10	9	10	10	10	8
Land	1	1	1	1	10	10	3	2
Pool	1	1	2	2	1	1	2	1
Golfing								
Holes	9	7	10	9	6	7	10	10
Acres	7	5	8	7	4	5	10	8
Tennis Courts	7	3	6	3	7	6	10	7
Outdoor Game Fields	6	5	4	4	6	7	10	10
Fishing Water	9	7	10	8	10	10	10	7
Recreation Water	8	5	8	5	10	10	10	6
Camping								
Sites	3	1	2	1	4	2	1	1
Acres	1	1	1	1	2	1	1	1
Picnicking								
Tables	5	3	4	3	8	6	7	4
Acres	1	1	1	1	2	2	3	2
Hiking Trails	10	10	10	10	10	10	10	10
Nature Trails	1	1	1	1	1	1	1	1
Snowmobile Trails	1	1	1	1	2	2	1	1
Hunting Small Game	2	2	8	8	10	10	1	1
Hunting Waterfowl	3	2	9	10	10	10	2	1

*Based on percent of need being supplied by present facilities: Example; if present facilities are 0-10 percent of those needed, priority is No. 1; 10-20 percent, priority is No. 2; 90-100 percent, priority is No. 10, etc.

Public access is a key factor to the utilization of recreational resources.

birdwatching, photography, nature study, etc., is needed in wildlife management programs. An intensive information program stressing the interrelationships between man and the ecosystem, the actual affects of regulated hunting upon wildlife populations, and sportsman ethics should become an important part of all natural resource budgets.

The development of recreation facilities and associated resources within the basin will require a coordinated program, enlisting the full cooperation of all governmental levels and the private sector. Study area and basin priorities may change when placed in a context of state and regional needs. The 1974 Minnesota State Comprehensive Outdoor Recreation Plan (SCORP) presents a framework for such a coordinated program, and provides the necessary guidance for future action. As a step in achieving a properly developed recreation system, SCORP is a major accomplishment. It deserves the full support of all resource and recreation interests, both in cooperative planning, and in providing adequate future funding.

L. AESTHETIC VALUES

Residents of the basin are concerned about the asethetics of the basin and have made efforts to preserve and develop areas and features in the basin that have aesthetic value. There is an effort to preserve natural wildlife habitat in the basin. Archeological sites showing Indian pectroglyphs have been preserved in Cottonwood County and the Indian-Whiteman historical landmarks have been restored in Yellow Medicine County. A scenic road route has been established north of Willmar.

However, there is a need for further development of the full aesthetic values in the region. One of the undeveloped aesthetic potentials that is of interest and value to the entire nation is an exposure of some of the oldest bedrock in the world, 3.8 billion years old, in the Minnesota River Valley near Morton and through Granite Falls. This feature has potential for inclusion into the national monument system.

M. LAND USE PROBLEMS

The use of land should follow a logical pattern depending on the limitations of the soils. When there is a deviation from this pattern, problems are usually encountered that will require special construction technique or management to correct.

There is not a tremendous conflict between rural and urban land use except in the Twin Cities fringe areas where some scattered development is allowed in rural areas. Parts of Hennepin, Dakota, Carver and Scott Counties, located in the northeastern portion of Area IV, are experiencing scattered urban development. Problems that are resulting from this scattered development are:

1. Land use conflicts between development and preservation of natural areas.
2. Loss of agricultural land to residential, commercial, and industrial development.
3. High cost of providing services for unguided urban growth.
4. Environmental impacts of the developments upon unsuitable land.
5. Potential effects of higher energy cost upon type and distribution of future urban/rural areas.
6. Erosion and sediment from developing areas.

Some of the problems of the urban fringe areas are also prevalent in rural areas, especially where the intensive utilization of rural lands for agriculture is interfering with maintaining areas for environmental and ecological reasons. Other land use problems in rural areas are the production of crops on areas with steep and erosive slopes, lack of conservation land treatment, pastures that border streams and result in streambank erosion, and the production of crops in flood plains.

The problems of erosion and flooding have been discussed earlier in this chapter. Potentials for solving these problems will be discussed under the erosion and flooding section of Chapter V. Potentials for solving other problems mentioned in this section will be discussed under the Land Use section of Chapter V.

N. PROJECTED ACREAGE REQUIREMENTS FOR AGRICULTURAL PRODUCTION

Benchmark projections reported in Table IV-17 indicate that the land resources are sufficient to produce the projected series C agricultural output for the basin, but falls short of producing the projected series E' output. Projected yield increases and improved technology coupled with increased efficiency from shifts in crop production between soil types and subareas are included as a part of the basin's production capacity.

TABLE IV-17. CURRENT AND PROJECTED ACREAGES OF MAJOR CROPS AND PASTURE USE, SERIES C AND SERIES E' ALTERNATIVES, MINNESOTA RIVER BASIN

Crop	Current Normal	1980		2000		2020	
		Series C	Series E'	Series C	Series E'	Series C	Series E'
	(Thousand Acres)						
Corn	2,394.7	2,668.9	2,577.5	2,854.0	3,026.9	3,136.1	2,969.4
Silage	323.5	251.1	254.6	235.3	239.4	234.9	230.1
Soybeans	1,851.5	2,707.9	3,128.7	2,473.9	3,670.2	2,330.5	3,678.9
Oats	786.1	588.0	565.7	605.4	713.1	560.6	721.2
Other Small Grains[1]	512.7	431.2	410.7	383.5	361.4	383.5	343.2
Specialty Crops[2]	108.4	108.4	120.5	108.4	106.4	108.4	91.5
Alfalfa	454.1	351.6	357.8	379.2	385.0	365.3	360.7
Other Hay	143.0	123.2	127.5	87.2	91.5	95.8	95.0
Cropland Pasture	674.4	572.2	474.1	523.5	527.0	480.9	484.4
Idle Land	965.9	402.5	196.3	531.1	[3]	455.6	[4]
Improved Pasture	604.8	606.1	606.1	622.9	622.9	622.5	622.5
Permanent Pasture	268.9	266.2	266.2	245.5	245.5	241.1	241.1
Grazed Forest	165.3	86.5	86.5	51.5	51.5	27.4	27.4

[1] Includes wheat, rye, barley and flax.
[2] Includes sugarbeets, potatoes, vegetables, orchards, etc.
[3] Projected crop acreages exceed cropland base by 918,100 acres.
[4] Projected crop acreages exceed cropland base by 774,100 acres.

In the current normal period, some 965,000 acres of cropland were idle in the basin.[1] It was assumed that this acreage would be available for future production and is included in the basin's production capacity. Less than 15,000 acres in the series E' were removed from the cropland base acreage for urban development by 2020 and approximately 60,000 acres were removed in the series C by 2020.

In the series C projections, major increases in acreage of corn and soybeans will be required. In the current normal, some 50 percent of the basin's cropland was used for corn and soybean production. The 1980 and 2000 projected acreage requirements for corn and soybeans represent an increase of about one million acres over the current normal of about 65 percent of the basin's cropland. Some reduction in the cropland acreage requirements was estimated for small grains and forage production. The acreage of permanent pasture was projected to decline slightly, but more of the acreage will be improved pasture with higher sustained yields. Grazed forest land is projected to decrease from about 50 percent of the current acreage to an estimated 15 percent of the acreage in 2000.

[1] This acreage includes conservation use only, temporarily idle, and open land formerly cropped as reported in the 1967 CNI.

In the series E' projections, the acreage requirements for meeting the corn and soybean production in 2000 would utilize an estimated 81 percent of the cropland base. Soybean acreage would need to double from the current normal acreage of 1,851,500 and corn acreage would have to increase over 25 percent from the current acreage of 2,394,700. Although a reduction in the acreage of small grains, silage, hay and cropland pasture are estimated, these acreages are not sufficient to provide the additional capacity needed to produce the series E' projected levels of crop production.

The series C outputs are estimated to use approximately 95 percent of this cropland base through the projection periods. This level of utilization is assumed to represent nearly full capacity at the current state of land and water resource development. The higher levels of output as projected in the series E' alternative cannot be produced without extensive resource development, greater yield increases than assumed and/or greater shifts in production between subareas.

CHAPTER V

LAND AND WATER DEVELOPMENT POTENTIAL

A. AGRICULTURAL LAND – CONSERVATION MANAGEMENT SYSTEMS

Potentially every acre of agricultural land in the basin could be managed, in regard to land use, in accordance with its greatest capability and could be treated in accordance with its need. It is reasonable, however, to expect that desired land treatment and proper land use will be less than the ideal goal because of such factors as land ownership changes, economics, depreciation of mechanical practices, and lag in application of conservation practices. Projected land use and land treatment expected to be installed through going programs are shown in Tables V-1 and V-2. Table V-1 displays expected short-term effects by 1985 and Table V-2 displays anticipated long-term going land treatment results by 2000. Costs for short- and long-term programs are displayed in Table V-3 and Table V-4, respectively.

It is projected that some 1,760,000 additional acres of agricultural land will be adequately treated by 2000, bringing the total land with adequate treatment to over 5.5 million acres, or 55 percent of the agricultural land. This varies by study area from 50 percent in Study Area II to 61 percent in Study Area III. Projected treatment varies due to variation in the types and extent of dominant problem needing treatment, resultant manpower requirements for technical assistance, and costs. It is projected that current normalized costs of projected land treatment to 2000 will amount to nearly 176 million dollars or an average cost of approximately $100 dollars per acre treated.

TABLE V-1. PROJECTED CONSERVATION TREATMENT BY LAND USE BASED ON PROJECTIONS TO 1985, MINNESOTA RIVER BASIN

Practice or Activity	Treatment Adequate	Treatment Needed	Total
		Acres	
CROPLAND			
Residue and Annual Cover	1,563,880	318,800	1,884,680
Sod in Rotation	382,690	1,065,560	1,446,250
Contouring Only	233,760	463,000	696,760
Stripcropping, Terracing, Diversions	227,590	851,140	1,078,730
Permanent Cover	117,630	38,460	156,090
Drainage System	1,216,130	1,720,640	2,936,770
TOTAL 1985 CROPLAND TREATED	3,741,680	4,457,600	8,199,280
PASTURE			
Needs Protection Only	167,100	319,000	486,100
Needs Improvement Only	87,500	92,480	179,980
Reestablishment of Vegetative Cover	43,040	62,220	105,260
Brush Control and Improvement	22,700	29,350	52,050
No Treatment Feasible	–	41,740	41,740
Change in Land Use	–	6,190	6,190
TOTAL 1985 PASTURE TREATED	320,340	550,980	871,320
FOREST			
Commercial Forest Land	108,860	179,370	288,230
Noncommercial Forest	22,450	9,030	31,480
TOTAL 1985 FOREST TREATED	131,310	188,400	319,710
OTHER LAND			
TOTAL 1985 OTHER LAND TREATED	456,180	144,670	600,850
TOTAL AGRICULTURAL LAND	4,649,510	5,341,650	9,991,160

TABLE V-2. PROJECTED CONSERVATION TREATMENT BY LAND USE BASED ON PROJECTIONS TO 2000, MINNESOTA RIVER BASIN

Practice or Activity	Treatment Adequate	Treatment Needed	Total
		Acres	
CROPLAND			
Residue and Annual Cover	1,809,700	72,980	1,884,680
Sod in Rotation	437,230	993,200	1,428,430
Contouring Only	271,740	425,020	696,760
Stripcropping, Terracing, Diversions	278,240	800,590	1,078,730
Permanent Cover	142,430	13,660	156,090
Drainage System	1,549,120	1,387,650	2,936,770
TOTAL 2000 CROPLAND TREATED	4,488,460	3,693,000	8,181,460
PASTURE			
Needs Protection Only	215,060	269,320	484,380
Needs Improvement Only	109,620	69,810	179,430
Reestablishment of Vegetative Cover	56,950	48,190	105,140
Brush Control and Improvement	29,700	22,140	51,840
No Treatment Feasible	–	41,740	41,740
Change in Land Use	–	5,960	5,960
TOTAL 2000 PASTURE TREATED	411,330	457,160	868,490
FOREST			
Commercial Forest Land	118,830	166,710	285,540
Noncommercial Forest	22,720	8,500	31,220
TOTAL 2000 FOREST TREATED	141,500	175,210	316,760
OTHER LAND			
TOTAL 2000 OTHER LAND TREATED	463,710	134,610	598,320
TOTAL AGRICULTURAL LAND	5,505,050	4,459,980	9,965,030

By 2000, it is projected that 1,573,000 additional acres of cropland will be adequately treated with the total acreage adequately treated reaching 4,489,000 acres, or 55 percent of the total cropland. Study Area III is projected to reach 61 percent cropland adequately treated, while Study Area II will attain 49 percent. Study Areas I and IV are expected to reach 55 percent and 57 percent, respectively. Further, it is projected that 342,000 acres of Study Area I cropland will receive adequate treatment at an average cost of $118 per acre. Projected adequate treatment of cropland in Study Area II on 372,000 acres will average $114 per acre. Projected adequate treatment of cropland in Study Area III on 576,000 acres will cost an average of $62 per acre. Adequate treatment in Study Area IV on 333,000 acres will cost an average of $121 per acre. Treatment costs vary considerably by study area because of varying dominant treatment problems and resultant projected types of treatment application.

Drainage is a costly practice in relation to most practices. Cropland soils in Study Area I consist of 52 percent land capability subclass "w" soils which require drainage for maximum production. Study Area III has only 30 percent. A higher percentage of the projected treatment application in Study Area I involves drainage; consequently, the average cost of treatment per acre is higher in Study Area 1.

Thirty-seven percent, 582,000 acres, of the cropland projected to receive adequate treatment by 2000 involves drainage practices at an average cost of $236 per acre. While drainage affects only 37 percent of the area treated, the costs constitute 88 percent of the total 156 million dollar land treatment costs on cropland projected to 2000.

The remaining 63 percent, 991,000 acres, involves other management and/or mechanical practices principally designed to reduce erosion and resultant sedimentation, maintain productivity, conserve moisture, and protect the soil resource for sustained production. Costs for

TABLE V-3. COST OF PROJECTED CONSERVATION TREATMENT BY LAND USE FOR TREATMENT APPLIED FROM 1974 TO 1985, MINNESOTA RIVER BASIN

Practice or Activity	Installation Cost	Technical Assistance Cost	Total Cost
		1974 Dollars	
CROPLAND			
Residue and Annual Cover	$ 1,824,000	$ 91,300	$ 1,915,300
Sod in Rotation	2,332,100	116,600	2,448,700
Contouring Only	180,400	36,100	216,500
Stripcropping, Terracing, Diversions	3,391,200	847,900	4,239,100
Permanent Cover	1,350,500	67,600	1,418,100
Drainage System	56,027,300	2,801,400	58,828,700
TOTAL 1985 CROPLAND TREATED	$65,105,500	$3,960,900	$69,066,400
PASTURE			
Needs Protection Only	$ 32,800	$ 1,600	$ 34,400
Needs Improvement Only	445,800	22,300	468,100
Reestablishment of Vegetative Cover	546,000	27,300	573,300
Brush Control and Improvement	463,200	23,100	486,300
No Treatment Feasible	–	–	–
Change in Land Use	–	–	–
TOTAL 1985 PASTURE TREATED	$ 1,487,800	$ 74,300	$ 1,562,100
FOREST			
Commercial Forest Land	–	–	–
Noncommercial Forest	–	–	–
TOTAL 1985 FOREST TREATED	$ 1,117,700	$ 111,800	$ 1,229,500
OTHER LAND			
TOTAL 1985 OTHER LAND TREATED	$ 5,400,000	$ 540,000	$ 5,940,000
TOTAL AGRICULTURAL LAND	$73,111,000	$4,687,000	$77,798,000

these practices consitute the remaining 12 precent, 18.3 million dollars, of projected cropland treatment costs at an average of 19 dollars per acre.

About 155,000 additional acres of pastureland will be adequately treated during the projected period, with the total adequately treated by 2000 being some 411,000 acres or 47 percent of the total pastureland area. Present costs for treating this pastureland totals nearly 3.1 million dollars for an average cost of $20 per acre.

It is estimated that 142,000 acres, or 45 percent of the forest land area, will be adequately treated by 2000. This includes planting of trees in windbreaks and shelterbelts to provide protection for farmsteads, feedlots, and wildlife. Management practices on other areas will be utilized for the production of forest products. Additional treatment is projected for some 19,000 acres at a total cost of 2.6 million dollars.

An additional 13,000 acres of other agricultural land is projected to receive adequate treatment by 2000, with the total area adequately treated reaching 463,000 acres, or 77 percent of this land use. This includes agricultural waste management systems, gully control structures in odd areas, roadside erosion control measures, and other, generally more costly, practices for a total cost of 14.2 million dollars.

Land treatment practices are primary instruments contributing to full agricultural land and water development in the basin. The full development, utilization, and protection of land resources will require application of needed land treatment practices on some 4.5 million acres, 45 percent of the agricultural land, in addition to that projected to receive adequate

TABLE V-4. COST OF PROJECTED CONSERVATION TREATMENT BY LAND USE FOR TREATMENT APPLIED FROM 1974 TO 2000, MINNESOTA RIVER BASIN

Practice or Activity	Installation Cost	Technical Assistance Cost	Total Cost
		1974 Dollars	
CROPLAND			
Residue and Annual Cover	$ 3,053,100	$ 152,700	$ 3,205,800
Sod in Rotation	3,695,600	184,800	3,880,400
Contouring Only	370,300	74,000	444,300
Stripcropping, Terracing, Diversions	6,430,200	1,607,600	8,720,100
Permanent Cover	2,590,500	129,600	2,720,000
Drainage System	130,950,100	6,547,500	137,497,600
TOTAL 2000 CROPLAND TREATED	$147,089,800	$ 8,696,200	$155,786,000
PASTURE			
Needs Protection Only	$ 80,600	$ 4,000	$ 84,600
Needs Improvement Only	998,800	49,900	1,048,700
Reestablishment of Vegetative Cover	1,370,600	65,000	1,445,600
Brush Control and Improvement	476,400	26,100	502,500
No Treatment Feasible	–	–	–
Change in Land Use	–	–	–
TOTAL 2000 PASTURE TREATED	$ 2,936,400	$ 145,000	$ 3,081,400
FOREST			
Commercial Forest Land	–	–	–
Noncommercial Forest	–	–	–
TOTAL 2000 FOREST TREATED	$ 2,397,600	$ 239,800	$ 2,637,400
OTHER LAND			
TOTAL 2000 OTHER LAND TREATED	$ 12,930,000	$ 1,293,000	$ 14,223,000
TOTAL AGRICULTURAL LAND	$165,353,800	$10,374,000	$175,727,800

treatment by 2000. Present day costs of projected remaining conservation treatment needs in the year 2000 are estimated at 585 million dollars. A further breakdown is shown in Table V-5.

B. SEDIMENT DAMAGE REDUCTION

The application of land treatment measures will maintain soil productivity for future generations. However, the extent that land treatment will improve surface water quality is difficult to predict. This is a complex problem which is contributed to by many sources, in addition to sheet and rill erosion. Programs specifically designed to have a great impact toward cleaning up surface water in localized areas with severe problems may have to concentrate on reducing soil loss below the allowable four tons/acre/year level.

1. Conservation Management Systems

Projected land treatment is expected to reduce sheet and rill erosion, the most significant erosion problem in the basin. The areas projected for treatment, which are expected to be adequately treated by 2000, are as follows:

a. Cropland – 1,573,000 acres
b. Pastureland – 155,000 acres
c. Forest land – 19,000 acres
d. Other agricultural land – 13,000 acres.

TABLE V-5. COST OF PROJECTED REMAINING CONSERVATION TREATMENT NEEDS BY LAND USE IN THE YEAR 2000, MINNESOTA RIVER BASIN

Practice or Activity	Installation Cost	Technical Assistance Cost	Total Cost
		1974 Dollars	
CROPLAND			
Residue and Annual Cover	$ 364,800	$ 18,200	$ 383,000
Sod in Rotation	24,830,200	1,241,500	26,071,700
Contouring Only	2,125,300	425,000	2,550,300
Stripcropping, Terracing, Diversions	48,029,400	11,515,500	59,544,900
Permanent Cover	683,000	34,200	717,200
Drainage System	312,221,400	15,611,100	327,832,500
TOTAL 2000 CROPLAND TREATED	$388,254,100	$28,845,500	$417,099,600
PASTURE			
Needs Protection Only	$ 269,300	$ 13,500	$ 282,800
Needs Improvement Only	1,745,400	87,300	1,832,700
Reestablishment of Vegetative Cover	2,891,400	144,600	3,036,000
Brush Control and Improvement	885,600	44,200	929,800
No Treatment Feasible	–	–	–
Change in Land Use	–	–	–
TOTAL 2000 PASTURE TREATED	$ 5,791,700	$ 289,600	$ 6,081,300
FOREST			
Commercial Forest Land	–	–	–
Noncommercial Forest	–	–	–
TOTAL 2000 FOREST TREATED	$ 21,901,400	$ 1,434.000	$ 23,335,400
OTHER LAND			
TOTAL 2000 OTHER LAND TREATED	$134,610,000	$13,461,000	$148,071,000
TOTAL AGRICULTURAL LAND	$540,717,200	$44,030,100	$584,747,300

Estimated reduction in gross soil erosion, as a result of this treatment is as follows:

a. Cropland – 3,350,000 tons/year
b. Pastureland – 230,000 tons/year
c. Forest land – 14,000 tons/year
d. Other agricultural land – 54,000 tons/year.

The estimated total effect on gross soil erosion on land projected to receive adequate treatment to 2000 is a reduction from 31.9 million tons/year to 28.3 million tons/year. The former figure is estimated to be reduced to 29.9 million tons/year in 1985. Further breakdowns of estimated projected soil loss by land use and SMRB areas are displayed in Tables V-6 and V-7.

The estimated 11 percent reduction in gross soil erosion to 2000 is not expected to have a significantly noticeable effect on surface water quality in the basin.

It is further projected that if all agricultural land in the basin was to receive adequate treatment, which would entail the reduction of soil loss on all acres currently excessive of the allowable level of four tons/acre/year, gross soil erosion would be reduced to an estimated 23.3 million tons per year. This amounts to a 27 percent reduction from the 1974 estimates.

TABLE V-6. PROJECTED CONSERVATION TREATMENT AND SOIL LOSS ON AGRICULTURAL LAND, MINNESOTA RIVER BASIN, 1985

Land Use	Study Areas	Total Acres (000)	Land Adequately Treated		Land Needing Treatment		Soil Loss Tons/Yr. (000)
			Acres (000)	Percent	Acres (000)	Percent	
Cropland	I	1,860	785	12	1,075	58	5,441
	II	2,740	1,137	41	1,603	59	9,828
	III	2,019	1,041	52	978	48	7,604
	IV	1,580	779	49	801	51	4,675
	Total	8,199	3,742	46	4,457	54	17,548
Pasture	I	68	19	28	49	72	103
	II	303	103	34	200	66	527
	III	356	151	42	205	58	606
	IV	144	47	33	97	67	225
	Total	871	320	37	551	63	1,461
Forest	I	55	26	47	29	53	32
	II	66	25	38	41	62	45
	III	87	40	46	47	54	60
	IV	112	40	36	72	64	78
	Total	320	131	41	189	59	215
Other	I	96	77	80	19	20	87
	II	174	126	72	48	28	211
	III	206	154	75	52	25	244
	IV	125	99	80	26	20	118
	Total	601	456	76	145	24	660
Total	I	2,079	907	44	1,172	56	5,663
	II	3,283	1,391	42	1,892	58	10,611
	III	2,668	1,386	52	1,282	48	8,514
	IV	1,961	965	49	996	51	5,096
	Total	9,991	4,649	47	5,342	53	29,884

2. Land Use Regulations

Conservation management systems installed for sediment damage reduction have been largely of a voluntary approach – relying on the enlightened self-interest of the landowner coupled with the incentives of technical and financial assistance, Iowa has enacted a soil conservancy law which provides for regulation governing all land-disturbing activities, including those associated with agriculture. Minnesota and South Dakota do not have mandatory soil conservancy laws.

The continuing evolution of the nation's water control effort is accelerating the creation of a nationwide program to prevent pollution from agriculturally related and nonpoint sources. Section 208 of PL 92-500, the Federal Water Pollution Control Act Amendments of 1972, includes planning and implementing the means for reducing pollutants from all sources, including sediment. To comply with 208, states must develop a process to identify these sources and set forth procedures and methods to control them to the extent feasible. This may involve land use requirements and other mandatory regulation.

3. Critical Erosion Area Control

There is potential for a wide variety of gully and other critical area stabilization measures in the basin. Possible means of reducing the damages from these critical areas include the installation of conservation practices in the upland areas. Vegetative practices, together with proper land use, are indispensable in a sound soil and water management program. However,

TABLE V-7. PROJECTED CONSERVATION TREATMENT AND SOIL LOSS ON AGRICULTURAL LAND, MINNESOTA RIVER BASIN, 2000

Land Use	Study Areas	Total Acres (000)	Land Adequately Treated		Land Needing Treatment		Soil Loss Tons/Yr. (000)
			Acres (000)	Percent	Acres (000)	Percent	
Cropland	I	1,854	1,023	55	831	45	5,037
	II	2,739	1,342	49	1,397	51	9,371
	III	2,019	1,231	61	788	39	7,187
	IV	1,570	893	57	677	43	4,490
	Total	8,182	4,489	55	3,393	45	26,085
Pasture	I	68	26	38	42	62	95
	II	303	135	45	168	55	484
	III	355	191	54	164	46	550
	IV	142	59	42	83	58	208
	Total	868	411	47	457	53	1,337
Forest	I	54	28	52	26	48	31
	II	66	28	42	38	58	43
	III	87	43	49	44	51	56
	IV	110	43	39	67	61	76
	Total	317	142	45	175	55	206
Other	I	96	78	81	18	19	83
	II	174	128	74	46	26	205
	III	206	156	76	50	24	236
	IV	122	101	83	21	17	106
	Total	598	463	77	135	23	630
Total	I	2,072	1,155	56	917	44	5,246
	II	3,282	1,633	50	1,649	50	10,103
	III	2,667	1,621	61	1,046	39	8,029
	IV	1,944	1,096	56	848	44	4,880
	Total	9,965	5,505	55	4,460	45	28,258

there are many instances where vegetative measures and simple practices alone are inadequate to handle a concentration of water. In such cases, permanent structures play an important part in reinforcing or supplementing other practices. Grade stabilization structures in gully problem areas are needed in many cases. Other major concerns which have potential for critical area stabilization measures include degrading of tributaries and drainage outlets in the subwatersheds of the basin.

The installation of critical area stabilization measures is very costly. The majority of structures installed have been pipe drops with drainage areas ranging from 20 to 200 acres. The costs for these have been between $1,500 and $3,000. These have been principally on-farm measures. Areas requiring project type measures, although less frequent, will be considerably more costly to treat. Availability of proper cost-sharing, formation of pooling agreements, and availability of technical assistance will be the keys to installation of these measures.

In addition to preventing the destruction of the land resource, the potential exists to reduce damages to improvements such as roads, bridges, buildings, and fences located on affected lands. Potential land stabilization will reduce the production of damaging sediment which affects downstream landowners, communities, and the general public.

4. Streambank Erosion Control

Most measures to alleviate bank erosion have been of an emergency or temporary nature and have been aimed at protecting the most critical areas. It can be assumed that emergency measures will continue to be used for temporary protection. The installation of more permanent measures, such as rock revetments, channel linings, deflectors, and riprap, is desirable whenever local damages justify their use. Increases in the economic losses, due to future development in combination with possible advances in the technology of bank stabilization, may provide an economic basis to justify protection of relatively long reaches.

5. Roadside Erosion Control

There is significant potential for special roadside erosion control measures, in addition to continued maintenance and replacement. Many specific problems due to inadequate design can be corrected through stabilization techniques or redesign. Other more extensive problems can be corrected with special measures to the extent that funding and technical assistance are available.

C. FLOOD DAMAGE REDUCTION

Flood hazard analysis locates and appraises the flood hazard potential of the flood plains of the various tributaries and main river valley in the basis. These analyses have been authorized in many urban areas in the basin and one county (Table V-8).

TABLE V-8. FLOOD HAZARD STUDIES AND FLOOD INFORMATION REPORTS

Location (Town)	Study By	Completion Date
Canby, Minnesota	SCS	1977
Montevideo, Minnesota	Corps of Engineers	—
Mankato, Minnesota	Corps of Engineers	1974
Granite Falls, Minnesota	Corps of Engineers	1970
Marshall, Minnesota	Corps of Engineers	1975
Blue Earth County	SCS	1972

Depending on when the studies were made and their intensity at the time of study, the flooded area and frequency of occurrence is defined for the flood hazard areas. All areas in the basin will require some type of flood hazard study to meet the requirements of state law.

Four methods of flood damage reductions were considered in the Type IV Study of the Minnesota River Basin. They are: (1) Flood plain regulation; (2) Flood proofing; (3) Flood forecasting; and (4) Structural and nonstructural measures.

1. Flood Plain Regulations

All flood damage reduction programs should consider adoption of flood plain regulations. Such regulations are designed to achieve two general objectives:

a. Restrict or prohibit uses which are dangerous to health, safety or property in times of flood or which cause increases in flood heights or velocities;

b. Require that uses vulnerable to floods, including public facilities which service such uses, be protected against flood damage at the time of initial construction.

The Minnesota Legislature, in enacting the Flood Plain Management Act of 1969 (Minnesota Statutes, Chapter 104, as amended in 1973), recognized that flood plain management practices are necessary tools to protect human life and health and minimize property damages and economic losses. Under the Act, as amended, local units of government are required to prepare flood plain regulations within six months after sufficient data are available to define flood plain and floodway areas along watercourses within their respective jurisdictions.

The Statewide Standards and Criteria for Management of Flood Plain Areas in Minnesota, developed by the Department of Natural Resources, serve as the basis for determination of compliance with the Flood Plain Management Act and for administration and enforcement of local flood plain regulations. State flood plain management standards provide that the delineation of the flood plain and floodway and enactment of flood plain regulations are to be based on the regional (100-year frequency) flood.

2. Floodproofing

Flood damages exist because of valuable property being damaged by floods. Many times it is impractical to relocate or move the installation out of the danger area. Floodproofing of these installations by building above the hazard elevation or installing expensive equipment above the flood level or protecting behind levees with pumps to keep the seep water out will reduce flood damage.

3. Flood Forecasting

Flood forecasting has prevented much flood damage in the past. New detail and accuracy will assist future methods of flood forecasting. On the major streams, a system of flood forecasting is maintained by the U.S. Army Corps of Engineers and the National Weather Service. Future plans of the Weather Service are to install a storm radar system that will assist in early notification of flood hazards, even in upstream areas where it is only a few hours between storm and flood. Part of the system has been installed at the Minneapolis-St. Paul International Airport. The Sioux Falls, South Dakota, installation of the Aros Analysis Center has been conducting flood forecasting techniques and coordination procedures. The Flood Plain Management Section of the Department of National Resources has also coordinated the collection of flood data for prediction purposes.

4. Structural and Nonstructural Measures

Flood damage reduction by combination of structural and nonstructural measures is being studied and used in the Minnesota Basin.

Throughout the watersheds of the basin, conservation management systems reduce the erosion-sediment and flood damages to farms, roads, and streams. Ponds, diversions, terraces, and channel improvement protect damageable areas from the frequent occurring floods and storms throughout the basin.

Conservation management systems on the basin farms should be supplemented by dams above larger flood plain damaged areas. The use of conservation management systems protect crops and property where damages begin. A system of reservoirs on the main rivers can reduce the damages in downstream areas. In Study Area I, 117 sites were investigated and 65 were used in a system of downstream flood protection. A similar investigation in Study Area II identified more than 200 locations, and 81 were used in a system of downstream flood protection. The Corps of Engineers has investigated 17 sites on the major tributaries and main stem of the Minnesota River for effective flood control in the lower Minnesota River (see Table V-9 and Appendix B).

TABLE V-9. POTENTIAL RESERVOIR SITES

Study Area	Potential Sites	Storage Area (Acres/Feet)
Study Area I	76	194,740
Study Area II	93	142,402
Study Area III	16	78,505
Study Area IV	2	10,070
TOTAL	187	425,717

Channel modification will reduce damages in areas where applied. These modifications allow more of the floodwater to be contained in the floodway, thus reducing the area and duration of flooding on the valuable area. The Corps of Engineers considered both a channel and a floodway for the lower Minnesota River from New Ulm to the junction of the Mississippi River. Channel construction and environmental effects were too expensive, and a floodwater retarding structural system and a floodway were chosen as the most desirable solution.

Levees protecting an area may be an independent solution on the major streams. However, they may have to be coordinated with floodwater retarding structures where they confine floodwaters within low topographic boundaries. The Corps of Engineers have installed levees on the main Minnesota to protect Mankato, Chaska, St. Peter, and other urban areas. The SCS concluded that the use of levees in Study Area II, along with a system of floodwater retarding structures, gave a controlled system where flood damage reduction could be equally shared by all watersheds. Approximately 10.1 miles of levees were part of this system.

D. SURFACE DRAINAGE IMPROVEMENT

There is significant potential for onfarm surface and subsurface drainage improvement. Use of surface preparation, tile drains, open ditches, laterals, and main outlets can have a significant effect on the removal of excess water from present crop and pasture lands. These works will permit excess water to be managed, thereby permitting more efficient use of agricultural lands.

It is projected that 582,000 additional acres of cropland with a dominant drainage treatment need will be adequately treated through going programs by 2000. In addition, nearly 100,000 acres of cropland with other dominant treatment needs are projected to receive adequate treatment which includes drainage measures. The total projected cost of these drainage measures is estimated to be 138 million dollars.

This projected treatment through 2000, however, is only one-quarter of the present total onfarm drainage need. There is potential for additional and accelerated onfarm drainage measures if the full production potential of inadequately drained agricultural lands is to be realized. In addition, there is potential for small group or multilanduser coordination and/or major project action for outlets which, in many instances, will be essential for the completion of effective drainage systems.

E. WATER SUPPLY

Water supply development for municipal and industrial, as well as agricultural and other rural uses, will primarily involve utilization of the groundwater resource. The potential for groundwater development is considered good in the majority of the Minnesota River Basin (see Figure II-9, Groundwater Distribution Map). However, the following communities currently

utilizing groundwater are expected to have water supply problems starting during or after the year 2000 – Marshall, New Ulm, and Mankato[1]. Groundwater will continue to be the principal source of water supply for rural domestic and livestock use. The livestock water supply will continue to be supplemented with dugouts and farm ponds in the future.

A study of surface water potential has revealed that Granite Falls' future water supply needs can continue to be supplied by the Minnesota River through 2020. Fairmont, which is also dependent on surface water, is not expected to have water supply problems prior to 2020[2].

An inventory of potential reservoir sites has been completed for each study area (see Appendix B). These inventories revealed that there are 187 potential sites with approximately 426,000 acre/feet of storage in the Minnesota River Basin. In general, these sites were limited to drainage areas of 100 square miles or less. Although the majority of the potential storage is required for floodwater, there is limited potential for some water supply use. It should be noted that these inventories reflect only the physical potential for storage in the basin, and economic justification of sites is not implied.

F. IRRIGATION

At present irrigation is not a significant practice in the Minnesota River Basin. Approximately 11,400 acres are currently being irrigated, and 70 percent of this irrigated land is in Study Area III. In Study Area III, 192,200 acres were identified as having good potential for irrigation. In addition, 132,800 acres, primarily in Study Areas I and III, were identified as having some potential for irrigation. A breakdown of irrigated areas and acreages with irrigation potential is given in Table V-10.

TABLE V-10. IRRIGATION POTENTIAL IN THE MINNESOTA RIVER BASIN

Study Area	Presently Irrigated	Good Potential for Irrigation	Some Potential for Irrigation
I	1,181	–	33,300
II	1,270	–	8,000
III	7,940	191,200	66,137
IV	981	–	25,319
TOTAL	11,372	191,200	132,756

Factors considered were: irrigable soils, water supply, and favorable cost return differentials.

The current and potential irrigation systems are likely to be sprinkler irrigation supplied by wells. Therefore, federally assisted group water resource projects are not needed for implementation. Some assistance through existing loan programs; e.g., individual Farmers Home Administration loans may be required due to large capital outlay involved in implementing irrigation systems.

G. FOREST LAND

Chapter IV discussed the effects Dutch elm disease and the lack of markets for forest products are having on forest lands in the basin. A good method of alleviating these effects would be establishing wood processing plants throughout the basin which would utilize the elm before

[1]Walton, William C., Water Resources Problems and Needs in Minnesota, 1974, Guidelines for Research Programs, June 1974.
[2]Ibid.

it is totally lost. These plants would create markets for other tree species as well. Several plants are suggested because they would serve the basin better than one. They should be located in proximity to the supply, and should vary in size, depending on the supply of timber in the area. Several small plants would also eliminate much of the shipping and travel costs associated with one plant. A group of counties could share the costs of establishing the complex, and then share in its profits once it became self-sufficient.

The plants would aid both landowner and timber harvester by providing new markets for forest products. The forest products that could be produced from basin forest resources include rough chips and waste fuel fiber, debarked chips, firewood, pallet lumber, and high grade lumber.

Benefits of the complex would be both environmental and economic.

1. Environmental enhancement due to the elimination of landfills for the disposal of diseased and dead trees and improved land management due to the new forest products market.

2. Economic enhancement due to increased employment, and the creation of viable wood products market.

These plants will not change the amount of land used for forest production. They will provide markets for the elm, and an additional market for other species. But timber production will remain a relatively unimportant industry in the basin.

Forest land in the basin could be used to a greater extent as recreation sites, wildlife habitat, and protection for critical areas. It provides some of the only remaining sites for recreation and wildlife. Many of the remaining forest areas in the basin are located on steep slopes or along waterways. In these locations trees provide protection from erosion and a buffer strip along waterways to trap sediment and nutrients before they enter the stream. Developing the forests for these uses will provide a better environment in the basin.

H. WASTE DISPOSAL

1. Sanitary Land Fill

The Solid Waste Division of the Minnesota Pollution Control Agency has developed rules and regulations for the location, design, and operation of sanitary land fills. To protect the surface and groundwaters of the state, all land fills must obtain a permit from the Minnesota Pollution Control Agency (MPCA). As of December 1974, there were 22 permitted land fills within the Minnesota River Basin.

2. Sewage Treatment Plants

As stated in Chapter 4 of this report, the PCA has determined that of the 133 communities in the basin, 79 must either upgrade or replace their current sewage treatment facilities, or currently have no facilities other than private septic tanks. The MPCA has investigated sewage treatment requirements in the basin. Their findings are included in the Minnesota River Basin, Water Quality Management Basin Plan, dated June 1975. This report was prepared by the MPCA, Division of Water Quality.

A substantial share of industrial waste is currently discharged through municipal waste treatment systems. This practice is expected to continue in the future.

3. Feedlots

Wastes from feedlots, barnyards, and other disposal areas are often picked up by surface runoff and carried into streams and lakes. This waste can deplete the oxygen supply in the streams and lakes and destroy fish and other aquatic life. Although all livestock waste is not a pollution hazard, runoff from feedlots must be controlled to avoid pulluting streams, ponds, and lakes.

Since April 16, 1971, a feedlot permit is required for all new livestock feedlots, poultry lots, and other animal lots. A permit is also required for expansion of existing operations by increasing the number of animals, for modifying existing operations, but not increasing animal units, and upon changing ownership of an operation. This permit must be obtained from the MPCA. Prior to 1971, 18 animal waste control structures have been installed in the basin.

Although total livestock numbers have not changed significantly, new technology and management practices have led to significant changes in their concentration. The general trend of larger and more concentrated feeding areas will continue.

There are approximately 376 livestock waste control structures in the basin (see Table V-11). Of these, 97 were installed during 1975 at an average cost of $7,100. These systems consist of one or more of the following components: holding pond, lined holding pond, earth storage facility, clean water diversion, polluted water diversion, lagoon, concrete tank, settling basin, and concrete storage facility (stacking). The systems installed during 1975 consisted of 151 conponents – 1.6 components per system. Financial assistance for the installation of a system is available from ASCS, who can help pay up to 50 percent of the cost not to exceed $2,500 for one farm or up to $10,000 for a watershed-wide program. In some counties the cost-sharing may be up to 80 percent.

I. FISH, WATERFOWL, AND WILDLIFE

Opportunities for improving fish and wildlife conditions in the basin are substantial. Nearly all rural land has potential to produce wildlife if management considerations are included for that purpose. Stream and lake improvements for fish are primarily limited by high installation costs or natural topographic conditions.

The degree to which fish and wildlife habitat needs (as described in Chapter lV) will be met depends mainly upon the desire and incentives provided to do so. Proper grazing of pastures and woodland, grassed waterways, woodlot and windbreak renovation or establishment, and cropland erosion control practices all provide benefits to landowners and to fish and wildlife. Although the Minnesota DNR hopes to acquire an additional 47,000 acres to complete the wildlife management areas of the basin, the greatest potential for habitat improvement remains on private land.

J. RECREATION

The potential for expanding recreation opportunities is excellent. The full development of this potential will depend primarily upon two limiting factors; the desire of the public to place land and water resources into recreational use, and the adequacy of funds to acquire the resources and/or provide facilities.

Minnesota's Recreation Plan (SCORP-1974) outlines regional potentials, and recommends development actions by the various levels of government and the private sector. The Minnesota River Basin lies mainly within Minnesota Economic Development Regions 4, 6, 8 and 9; and references to the SCORP plans of action for those regions should be made prior to future development of specific sites.

TABLE V-11. POLLUTION CONTROL STRUCTURES BY COUNTY, MINNESOTA RIVER BASIN[1]

County	Pre-1971	1971	1972	1973	1974	1975	Total	1975 Average Cost
Big Stone	6	10	5	4	6	5	36	4,653
Blue Earth	0	0	1	1	11	3	16	8,318
Brown	0	0	1	5	7	7	20	12,300
Carver	1	1	1	1	4	2	10	16,750
Chippewa	0	1	2	0	0	0	3	–
Cottonwood	1	3	4	5	11	8	32	2,582
Dakota	0	0	0	0	0	1	1	16,315
Douglas	0	0	2	1	3	5	11	3,478
Faribault	0	2	3	4	8	3	20	3,144
Freeborn	0	0	2	1	2	0	5	12,102
Grant	0	0	1	0	1	0	2	–
Hennepin	0	0	0	0	1	0	1	–
Jackson	0	0	0	0	1	1	2	2,575
Kandiyohi	0	0	1	2	1	2	6	8,349
Lac Qui Parle	2	1	0	4	4	3	14	2,867
LeSueur	0	0	4	0	2	1	7	11,959
Lincoln	1	2	2	1	3	3	12	267
Lyon	3	6	6	1	5	9	30	6,504
McLeod	0	0	0	0	0	1	1	7,230
Martin	0	0	1	0	1	0	2	588
Murray	0	0	0	0	0	1	1	14,950
Nicollet	0	3	5	1	1	4	14	4,076
Otter Tail	0	0	1	0	1	0	2	–
Pipestone	0	0	0	0	0	0	0	–
Pope	1	1	2	0	1	2	7	5,073
Redwood	2	5	5	0	5	6	23	6,200
Renville	1	0	0	2	2	4	9	2,220
Rice	0	0	1	0	2	1	4	11,288
Scott	0	0	0	0	1	1	2	3,500
Sibley	0	2	3	2	5	4	16	7,916
Steele	0	0	1	0	0	0	1	–
Stevens	0	1	5	0	3	2	11	9,251
Swift	0	0	2	4	8	11	25	11,266
Traverse	0	0	0	0	0	0	0	–
Waseca	0	2	2	1	12	3	20	6,539
Watonwan	0	0	0	0	2	0	2	–
Yellow Medicine	0	0	3	0	1	4	8	4,592
TOTAL	18	40	66	40	115	97	376	7,093

[1]Percent of county in basin equals systems installed in basin. Does not include counties in South Dakota and Iowa.

The proposed Minnesota Valley Trail has excellent potential for recreation development. The needs for additional camping and picnicking facilities, as well as the needed trails for snowmobiles and nature study, could all be met along the Minnesota River Corridor and it's associated tributaries. An important aspect of this proposal is the inclusion of the major historical and scenic sites of the basin within the corridor and trail system. The Minnesota Valley Trail Proposal has excellent potential for enhancing the environmental, historical, recreational, and esthetic values of the basin, the state, and region.

With sufficient access to all lakes having recreation potential in Study Areas I, II and IV; water based activity facilities will remain deficient. Potential sites for new multipurpose reservoirs (flood prevention and fish, wildlife, or recreation), inventoried during this study, would add about 19,200 additional acres of water throughout the basin (Table V-12). There is a potential to meet more of the demand for lake activities in these study areas by intensive use of all present and future lakes through time and space zoning management plans. Study Area III lakes, given full development and adequate facilities, have good potential for supplying some additional opportunities for meeting basin-wide needs, although it is unlikely that those opportunities would reduce the demands in the other study areas.

TABLE V-12. RESERVOIR SITES WITH RECREATION, FISH, AND WILDLIFE DEVELOPMENT POTENTIAL,* MINNESOTA RIVER BASIN

	Study Area I	Study Area II	Study Area III	Study Area IV	Basin Totals
Recreation and Fishing					
Sites	19	5	6	1	31
Acres	4,080	682	2,992	500	8,254
Fishing Only					
Sites	6	13	3	–	22
Acres	1,045	1,206	8,700	–	10,951
Fishing (Total)					
Sites	25	18	9	1	53
Acres	5,125	1,888	11,692	500	19,205
Wildlife Sites	29	9	1	–	39
Total Sites	54	27	10	1	92
Total Acres	5,125	1,888	11,692	500	19,205

*NOTE: Only those sites with flood control feasibility were evaluated for multiple use. Many noninventory sites would have single purpose potential (especially for wildlife developments). See Appendix B, "Potential Reservoir Site Inventory".

Evaluation Criteria

Recreation – Minimum of 50 acres of permanent pool and 10' depth above sediment pool.

Fishing – 12'–15' minimum total depth and 50 acres of pool. Judgment was used on some sites where drainage area and ratio of deep to shallow water were potentially limiting factors.

Wildlife – 12' maximum depth with judgment used on sites where ratio of deep to shallow water were potentially limiting factors. Dam height 20' or less, 25 acre minimum.

Many of the rivers and streams have potential to supply fishing and canoeing activities at much higher levels of use than at present. Although stream improvements for fish habitat are costly, the combination of fishing, canoeing, picnicking, and camping potentials on these tributaries could help to relieve the demand for these activities at lakes.

The availability of hunting and fishing activities could be increased by providing more access to private lands and public waters. However, there is a high potential for fish and wildlife habitat improvement which would greatly increase hunting and fishing opportunities by increasing game species populations. State and Federal Wildlife Management Areas should be used for additional recreational activities as well as public hunting. These acres could provide opportunities for nature study, photography, outdoor classrooms, and other nonconsumptive, or educational uses.

The need for private development of many of the future facilities is emphasized by SCORP and potentials are good throughout the basin. Fish ponds, resorts, campgrounds, shooting ranges, hunting preserves, swimming pools, and tennis courts can all be provided by private groups and individuals. Cooperative ventures by local sportsman groups and private landowners have been successful in establishing snowmobile trails, wildlife improvement, natural areas, and cross-country skiing courses. These and similar activities are highly desirable and necessary for the future development of facilities by the private sector. Local and county governments can provide leadership, direction, and cooperative programs to these private efforts.

K. LAND USE

The potential for avoiding future land use conflicts in the basin is good. In recent years, zoning has been used to guide the use of land in both urban and rural areas. Properly used, zoning can be an effective tool in guiding growth into desired areas. However, in order for zoning to be effective, there is a need for additional land resource data so that wise land use

decisions can be made. The capability, hazards, and limitations of land for multiple uses need further development.

Two publications, *Interpretations of Soil Landscapes and Geomorphic Regions — Twin Cities* (Extension Bulletin 320) and *Soil Landscapes and Geomorphic Regions — Twin Cities Metropolitan Area Sheets* (Miscellaneous Report 130) are available through the University of Minnesota Experimental Stations. These publications list soil limitations for a variety of land uses and give other pertinent information that should be considered in site selection.

Appendix C of this report contains maps which locate priority land use areas for agriculture, green span, and woodland. These maps can be useful in zoning land for these and related uses.

Other alternatives that have potential toward solving recognized land use problems are:

1. Identification of areas with erosion and sedimentation hazards.
2. Encourage maintenance and protection of wetlands and natural drainage systems.
3. Encourage residential development within or contiguous to the urbanized portions of the basin.
4. Adopt a tax structure which would maintain agricultural land.
5. Require erosion and sediment control practices on agricultural land with erosion hazard, and on urban construction sites.

These are only a few of the many potentials for solving land use problems. Chapter VIII will give other recommendations that will be instrumental in reducing these conflicts.

CHAPTER VI

EXISTING PROJECTS AND PROGRAMS

VI – EXISTING PROJECTS AND PROGRAMS

A. INTRODUCTION

Opportunities for solving identified problems and meeting anticipated needs through federal, state and local agencies and programs are presented in this chapter. Although service is available through these agencies, the initial requirement for assistance generally rests with the residents and landowners in the basin. Properly understood and utilized, these programs represent a valuable resource upon which local units can draw for the solutions of community problems and the attainment of community goals. Land treatment measures, such as terraces, waterways, and the establishments of grass or trees, will be accomplished only when the individual landowner is motivated to do so. Other measures, such as floodwater retardation, municipal and industrial water supply, or public recreation facilities or structures, require group or community action. Land treatment measures, when combined with a structural program, provide an integrated watershed management program.

There is also a continuing program to inform landowners of the assistance available from these agencies in order that they may select the combination of programs that best meet their needs and desires.

B. USDA PROGRAMS

1. Public Law – 46

This law established the Soil Conservation Service (SCS) and made SCS responsible for developing and carrying out a national program of conservation and development of land and water resources.

The SCS has an objective of integrating the planning of land use and the installation of conservation treatment in harmony with the capability and needs of the land. To accomplish this, SCS employs scientists and technologists from many disciplines to diagnose land and water resource problems and prescribe successful treatment and use.

Most of the on-the-land SCS assistance to landowners is channeled through local soil and water conservation districts. Some of the conservation practices the SCS has offered technical assistance on in the basin include:

Conservation Cropping Systems	Grass Waterways
Critical Area Planting	Minimum Tillage
Drainage Field Ditches	Pasture and Cropland Management
Grade Stabilization Structures	Crop Residue Use
Tile Drains	Terraces
Fish Pond Management	Land Grading

These measures have solved numerous erosion, sediment, and drainage problems in the basin which has resulted in increased agricultural yields, and reduction in crop damage. There are still many areas in the basin having land and water resource problems and additional work to apply more conservation practices must be undertaken in the future.

The SCS also administers the Soil Survey Program which surveys the soil resource for the nation. This program examines soils in the field and in laboratories; their description and classification; the mapping of kinds of soils; the interpretation of soils according to their adaptability for various crops, grasses, and trees; their behavior under use or treatment for plant production or for other purposes; and their productivity under different management systems.

When available, this information is valuable in the selection of building sites, production of crops, location of recreation development and many other undertakings where the soils will have a major effect. Figure VI-1 shows the status of the soil survey in the basin.

2. **Public Law – 566**

Under this program, technical and financial assistance to state and local organizations is provided for planning, designing and installing watershed works of improvement. Cost-sharing is provided for flood prevention, irrigation, drainage, sedimentation control, fish and wildlife development, and public recreation. Long-term credit can be obtained by local interest for their share of the cost. The Soil Conservation Service of the United States Department of Agriculture administers this program which provides a means of solving watershed protection and flood prevention problems which cannot be adequately met by other going programs.

Currently there are 26 PL-566 projects at various stages of development in the basin. The status of these projects is shown on the USDA Project Status Map (Figure VI-2).

The Forest Service is responsible for the forestry phase of PL-566 watershed projects and for soil and water conservation applicable to land used for forestry purposes.

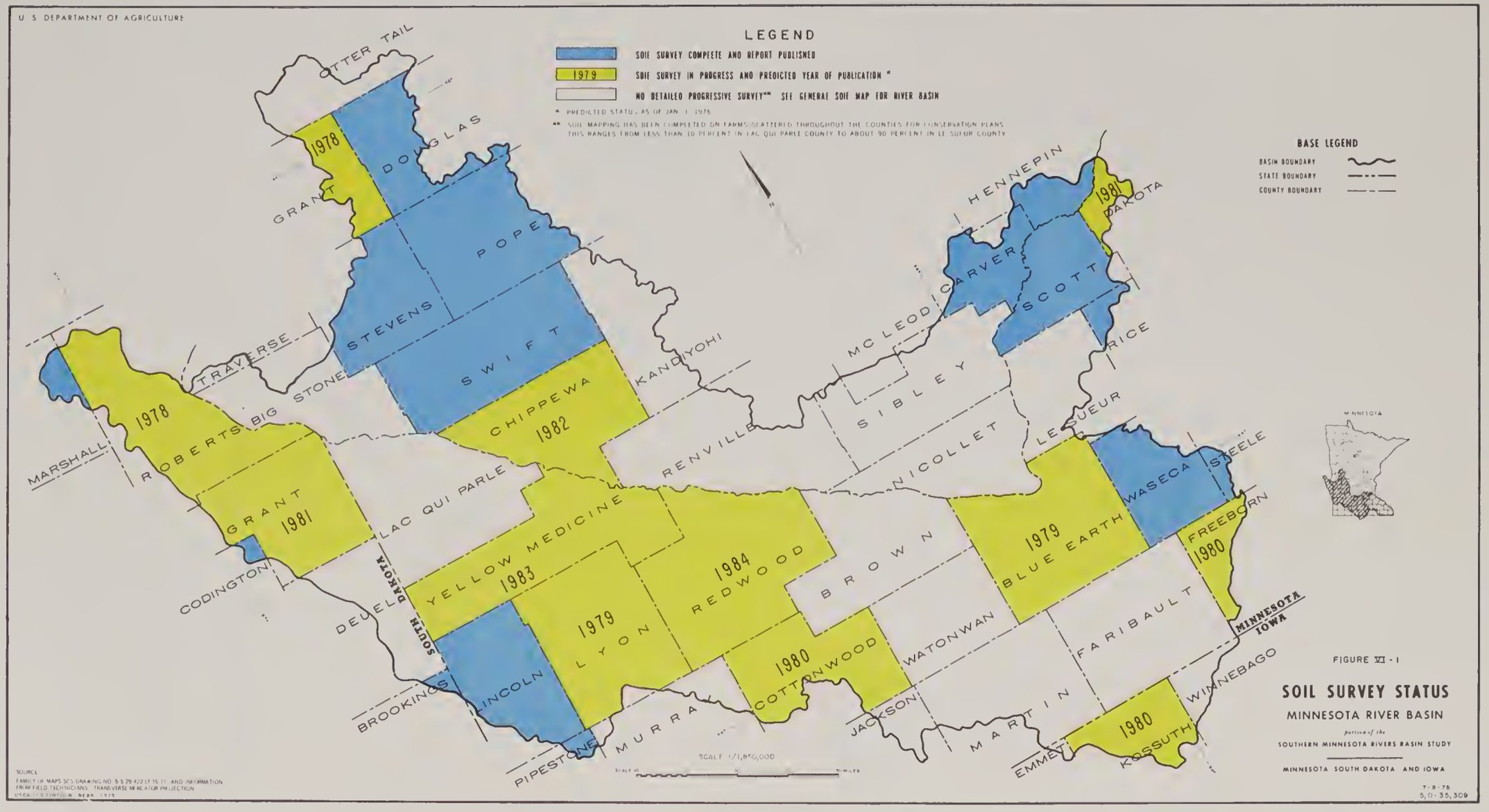
3. **Resource Conservation and Development Projects (RC&D)**

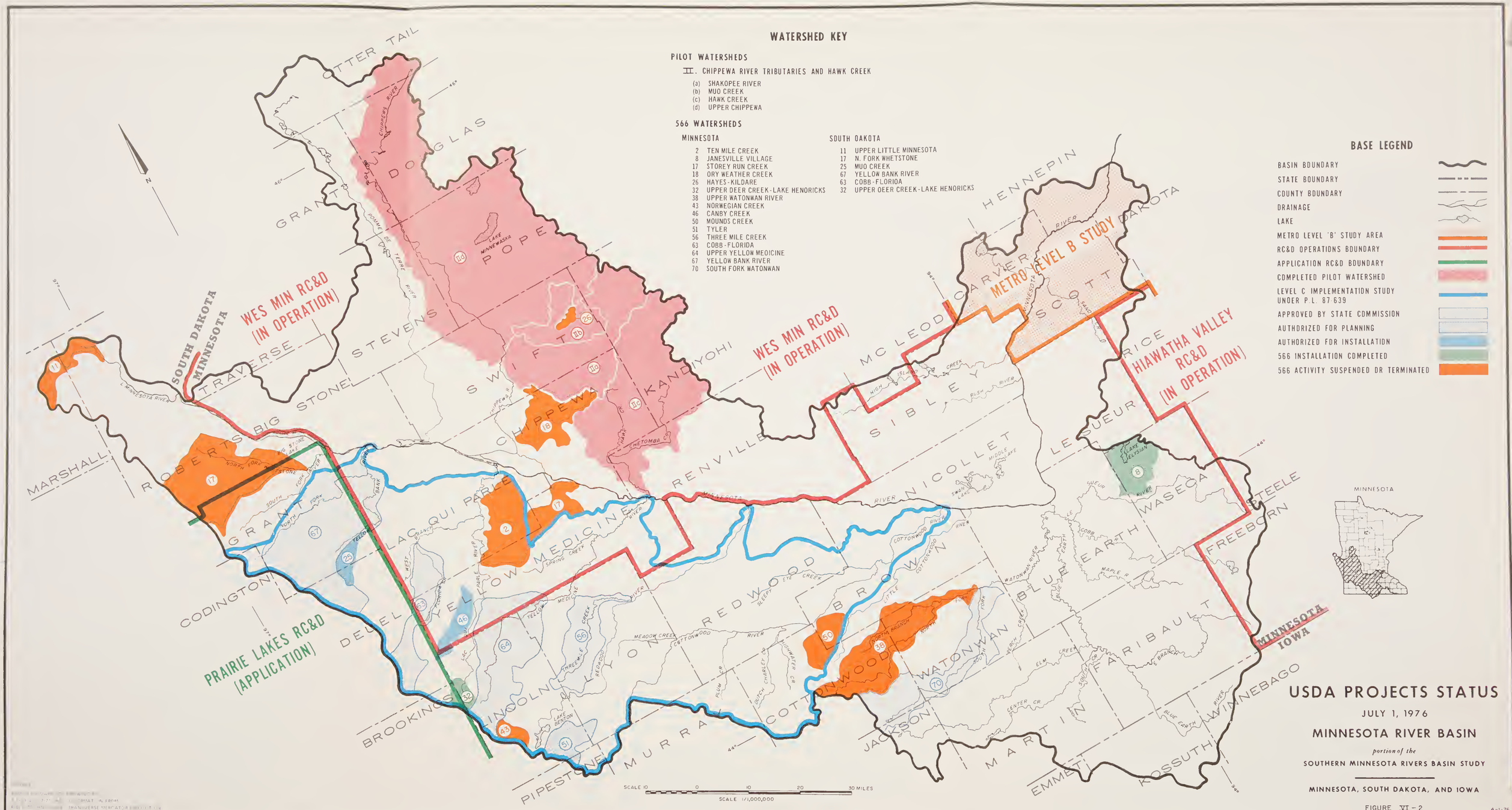
The RC&D was authorized by the Food and Agriculture Act of 1962. It expands opportunities for conservation districts, local units of government and individuals to improve their communities in multi-county areas. To carry out the program, financial and technical assistance may be provided to sponsors in carrying out eligible measures having community benefits. They are:

1. Critical area treatment (erosion and sediment control)
2. Flood prevention
   a. Structures
   b. Land stabilization
3. Public water-based recreation developments
4. Public water-based fish and wildlife developments
5. Farm irrigation
6. Land drainage
7. Soil and water management for agricultural related pollutant control
8. Accelerated services.

The basin includes parts of three RC&D projects. The Hiawatha Valley RC&D project encompasses portions of three counties in the south and southeast portion of the basin. The WesMin RC&D project encompasses all or parts of twelve counties in the northern portion of the basin. An application has been made for the Prairie Lake RC&D project in South Dakota. It will include parts of four counties within the basin. (See USDA Project Status, Figure VI-2.)

The Soil Conservation Service has leadership in this program. Assistance is provided where acceleration of going programs of resource conservation, development and utilization will increase economic opportunities for local people.


U S DEPARTMENT OF AGRICULTURE
LEGEND
SOIL SURVEY COMPLETE AND REPORT PUBLISHED
1979
SOIL SURVEY IN PROGRESS AND PREDICTED YEAR OF PUBLICATION *
NO DETAILED PROGRESSIVE SURVEY** SEE GENERAL SOIL MAP FOR RIVER BASIN
* PREDICTED STATUS AS OF JAN 1 1976
** SOIL MAPPING HAS BEEN COMPLETED ON FARMS SCATTERED THROUGHOUT THE COUNTIES FOR CONSERVATION PLANS THIS RANGES FROM LESS THAN 10 PERCENT IN LAC QUI PARLE COUNTY TO ABOUT 90 PERCENT IN LE SUEUR COUNTY
BASE LEGEND
BASIN BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
OTTER TAIL
DOUGLAS
GRANT
POPE
STEVENS
SWIFT
TRAVERSE
BIG STONE
KANDIYOHI
CHIPPEWA
RENVILLE
MARSHALL
ROBERTS
GRANT
LAC QUI PARLE
CODINGTON
DEUEL
SOUTH DAKOTA
YELLOW MEDICINE
LYON
REDWOOD
BROWN
BROOKINGS
LINCOLN
MURRAY
PIPESTONE
COTTONWOOD
WATONWAN
JACKSON
MARTIN
EMMET
KOSSUTH
FARIBAULT
WINNEBAGO
MINNESOTA
IOWA
HENNEPIN
DAKOTA
CARVER
SCOTT
MCLEOD
SIBLEY
NICOLLET
LE SUEUR
RICE
BLUE EARTH
WASECA
STEELE
FREEBORN
1978
1981
1982
1983
1984
1979
1980
SCALE 1/1,850,000
SOURCE
FAMILY OF MAPS SCS DRAWING NO. 6 S 29 422 (7 15 71) AND INFORMATION FROM FIELD TECHNICIANS TRANSVERSE MERCATOR PROJECTION
USDA SOIL CONSERVATION SERVICE LINCOLN NEBR 1975
FIGURE VI - 1
SOIL SURVEY STATUS
MINNESOTA RIVER BASIN
portion of the
SOUTHERN MINNESOTA RIVERS BASIN STUDY
MINNESOTA SOUTH DAKOTA AND IOWA
7-8-76
5,0-35,309


WATERSHED KEY
PILOT WATERSHEDS
II. CHIPPEWA RIVER TRIBUTARIES AND HAWK CREEK
(a) SHAKOPEE RIVER
(b) MUD CREEK
(c) HAWK CREEK
(d) UPPER CHIPPEWA
566 WATERSHEDS
MINNESOTA
2 TEN MILE CREEK
8 JANESVILLE VILLAGE
17 STOREY RUN CREEK
18 ORY WEATHER CREEK
26 HAYES-KILDARE
32 UPPER DEER CREEK-LAKE HENORICKS
38 UPPER WATONWAN RIVER
43 NORWEGIAN CREEK
46 CANBY CREEK
50 MOUNDS CREEK
51 TYLER
56 THREE MILE CREEK
63 COBB-FLORIDA
64 UPPER YELLOW MEDICINE
67 YELLOW BANK RIVER
70 SOUTH FORK WATONWAN
SOUTH DAKOTA
11 UPPER LITTLE MINNESOTA
17 N. FORK WHETSTONE
25 MUD CREEK
67 YELLOW BANK RIVER
63 COBB-FLORIDA
32 UPPER OEER CREEK-LAKE HENORICKS
BASE LEGEND
BASIN BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
DRAINAGE
LAKE
METRO LEVEL 'B' STUDY AREA
RC&D OPERATIONS BOUNDARY
APPLICATION RC&D BOUNDARY
COMPLETED PILOT WATERSHED
LEVEL C IMPLEMENTATION STUDY UNDER P.L. 87-639
APPROVED BY STATE COMMISSION
AUTHORIZED FOR PLANNING
AUTHORIZED FOR INSTALLATION
566 INSTALLATION COMPLETED
566 ACTIVITY SUSPENDED OR TERMINATED
WES MIN RC&D (IN OPERATION)
WES MIN RC&D (IN OPERATION)
METRO LEVEL B STUDY
HIAWATHA VALLEY RC&D (IN OPERATION)
PRAIRIE LAKES RC&D (APPLICATION)
MINNESOTA
IOWA
SOUTH DAKOTA
MINNESOTA
OTTER TAIL
GRANT
DOUGLAS
POPE
STEVENS
TRAVERSE
BIG STONE
SWIFT
CHIPPEWA
KANDIYOHI
MC LEOD
CARVER
HENNEPIN
DAKOTA
SCOTT
RICE
LE SUEUR
MARSHALL
ROBERTS
GRANT
CODINGTON
DEUEL
LAC QUI PARLE
YELLOW MEDICINE
RENVILLE
SIBLEY
NICOLLET
WASECA
STEELE
FREEBORN
BROOKINGS
LINCOLN
LYON
REDWOOD
COTTONWOOD
BROWN
BLUE EARTH
FARIBAULT
MARTIN
JACKSON
WATONWAN
PIPESTONE
MURRAY
EMMET
KOSSUTH
WINNEBAGO
SCALE 10 0 10 20 30 MILES
SCALE 1:1,000,000
USDA PROJECTS STATUS
JULY 1, 1976
MINNESOTA RIVER BASIN
portion of the
SOUTHERN MINNESOTA RIVERS BASIN STUDY
MINNESOTA, SOUTH DAKOTA, AND IOWA
FIGURE VI - 2
4-1-76
5,S-35,629

4. Clarke-McNary Act

Professional and financial assistance is provided to states for fire protection on non-federal forestland. The states administer the protection programs and are reimbursed from federal funds up to 50 percent of expenditure. Federal participation includes services such as assisting in training personnel, development and procurement of better fire equipment and tools, preparation of fire plans, and direction of the nationwide forest fire protection program.

5. Cooperative Forest Management Act of 1950

States are provided financial and technical assistance to assist private forest landowners in practicing multiple-use forest management. The cooperative forest management program is administered by the state and reimbursed from federal funds on a cost-sharing basis. Private forest landowners are provided on-the-ground technical assistance by professional foresters employed by the state.

States may also receive financial and professional assistance for sawmill operators and other processors of forest products for improved logging, processing and manufacturing techniques, marketing information and safety.

6. Farmers Home Administration

This United States Department of Agriculture agency administers many programs available to landowners and rural communities in the basin.

Among the services are:

Emergency loans
Farm ownership loans
Financial assistance to small towns and rural groups
Loans and grants for farm labor housing
Loans for forestry purposes
Loans for recreation purposes
Loans to rural families with low incomes
Operating loans
Rental loans
Rural housing loans
Rural renewal loans

Of particular importance in the basin are farm ownership loans, financial assistance to small towns and rural groups, and loans for recreational purposes. Farm ownership loans are used for a variety of purposes, including providing basic soil treatment and land conservation measures as well as providing necessary water and water facilities. Also of significance is the program which provides financial assistance to small towns and rural groups and makes loans and grants to public and non-profit organizations which primarily serve rural areas to plan and develop domestic water supply and waste disposal systems. Loans are provided to operators or managers of family farms for the purpose of developing land and water resources; repair and construction of buildings; purchase land, equipment and related recreational items; and pay necessary operating expenses.

These programs can assist financially in solving major problems of sediment and erosion control, as well as providing municipal water, waste disposal systems, and recreational facilities.

7. **Agricultural Stabilization and Conservation Service (ASCS)**

The ASCS administers several United States Department of Agriculture programs in the basin area. One of these, the Agriculture Conservation Program (ACP) provides cost-sharing assistance to agricultural producers who undertake soil, water, forestry, and wildlife conservation practices on farmlands currently in agricultural production. The cost of such practices are shared between the federal government and the agricultural producer.

Technical assistance for ACP practices is rendered by the Soil Conservation Service and the Extension Service. This program can serve as a valuable tool in solving the erosion and sediment problems and other resource needs in the basin through the establishment of conservation practices.

8. **Public Law 87-639**

This law authorizes the Secretary of the Army and the Secretary of Agriculture to make joint investigations and surveys of watershed areas for flood prevention or the conservation, development, utilization, and disposal of water. Reports are made jointly on such surveys and investigations and submitted jointly to the Congress for approval. Funds are appropriated, as may be necessary, to carry out the purpose of this act. A study has been authorized under Public Law 87-639 for Study Area II.

9. **Extension Service**

The Extension Service's basic job is to help people identify and solve their farm, home, and community problems through use of research findings of the Department of Agriculture, the University of Minnesota, and programs administered by the Department of Agriculture. The Extension Service is very active in the basin in helping local people to solve many of their resource problems through their educational programs.

C. OTHER FEDERAL PROGRAMS

1. **U.S. Army Corps of Engineers** has authority to plan and construct major reservoirs and local protection measures for flood control and to improve navigation.

The Corps has conducted flooding studies throughout the basin which have resulted in the construction of numerous flood control measures. In addition to the primary flood control benefits of these projects, other benefits have been gained through the use of the projects for conservation and recreation purposes.

Under the authority of Public Law 85-500, a federal flood control project is being constructed on the Minnesota River and its tributaries at Mankato, North Mankato and Lehillier.

2. **Bureau of Outdoor Recreation** has responsibility for providing outdoor recreation areas and facilities on areas designated as state parks, state preserves, and natural lakes. This agency reviews all outdoor recreation plans prepared for county conservation boards and municipalities for participation in the land and water conservation fund program. It also reviews projects submitted by agencies for federal funding assistance.

3. **National Weather Service** is responsible for issuing flood warnings and advisory forecasts. There are thirteen locations that issue forecasts. These forecasts are based on observed precipitation and stages at upstream points and anticipated weather conditions. They are then distributed to the media for public information.

D. STATE AGENCIES

1. Department of Natural Resources is assigned the responsibility of conserving and promoting the wise use and management of the natural resources of the state.

Principle responsibilities are:

1. Provide management assistance to private owners of forest land.
2. Acquire, develop and maintain state parks, recreation areas, canoe and boating routes, wild and scenic rivers and trail systems.
3. Protect and manage the state's wildlife and fisheries resources to assure sustained yields, research to uncover new management methods and an ample supply of game and fish for Minnesotans.
4. Provide administrative leadership and guidance to the locally organized soil and water conservation districts.
5. Manage state-owned forest land.
6. Carry out state-local cooperative programs for management of floodplain and shore land areas.
7. Administer the use, allocation, and control of public waters.

2. Minnesota Pollution Control Agency has the responsibility of adopting standards and regulating the discharge of pollutants into the water, air, and land resources of the state.

3. Water Resource Board is vested with the jurisdiction, power and authority to establish a watershed district and to define and fix the boundaries. Upon filing of a nomination petition, a watershed district may be established.

4. Geological Survey is responsible for conducting geologic investigations in Minnesota. An essential part of its responsibility is to provide the geologic data needed to evaluate the state's groundwater resources. The survey was established by an act of the State Legislature and administration is under the Board of Regents of the University of Minnesota.

D. LOCAL ORGANIZATIONS

Soil and Water Conservation Districts are legally constituted units of state government created to administer soil and water conservation work within their boundaries. They sponsor or co-sponsor most watershed protection and flood prevention projects and resource conservation and development projects. By virtue of their broad activities, districts have an important role in the development of rural areas.

These districts focus attention on land and water problems, develop annual and long-range programs designed to solve problems, and enlist all the appropriate, available help from public and private sources that will contribute to the accomplishment of the district's goals.

CHAPTER VII

ALTERNATIVES CONSIDERED

INTRODUCTION

The basic objective in the formulation of alternatives is to provide the best use, or combination of uses, of water and related land resources to meet all foreseeable needs. Consideration is given to possible actions which will meet demands identified as local or regional, and which are considered essential to the most practical use of the basin resources.

Needs identified by the local people and the Policy Committee are grouped into five general categories:

1. Flood damage reduction
2. Improved drainage on agricultural lands
3. Land treatment
4. Safe dependable water supply
5. Additional outdoor recreation opportunities.

Solutions to these problems are as numerous as the problems themselves. In recent years, consideration for the environment has become a major issue in resource planning. Because of this concern for the biological environment by a variety of citizens and groups, planners must explore alternatives available that not only have economical benefits, but environmental benefits as well.

Alternatives considered to solve identified problems in the basin are divided into two categories, structural and no-structural. Because of the minimal adverse effect to the environment, non-structural alternatives should be used whenever possible.

A. NON-STRUCTURAL MEASURES

1. No Project

Past and present trends clearly show that development in the basin will continue even if no federally-assisted projects are initiated. Additional wetland will be drained and channels will be enlarged or constructed for the prevention of flooding. At the same time, other channels will continue to lose capacity, flooding, impaired drainage, sediment and erosion damage and the subsequent reduction in agricultural production will continue to be a problem in some areas.

There are 215,200 acres of wetland and 322,400 acres of forest land in the basin. If no project action is taken, some areas where it is economically feasible to drain or clear will be brought into production. It is possible that much of this land would be cleared and drained under project conditions, but adverse effects can be minimized.

The history of the basin's development indicates that several features of resource development, which many people consider undesirable, especially land clearing and channel improvement, will continue in spite of what is proposed here. Channel improvement works would be done as cheaply as possible to insure its functioning for water disposal. There is no indication that extra work would be done or extra expense incurred to minimize adverse effects on the environment. Very little, if any, capital from private sources has ever been expended for measures reducing adverse environmental effects of such work. Constructive action designed to minimize or mitigate the undesirable effects of resource development could be expected, only under a public-funded type project.

It appears reasonable to assume that if no project action is taken, more adverse effects on fish and wildlife, aesthetic, and other environmental values will result than would not result from federally designed and coordinated projects.

2. **Environmental Corridor** (See Figure VII-2 at end of this chapter)

The environmental corridor is a new concept of resource preservation. Through the corridor system, land, water, recreation areas, historical sites, towns, and other people-oriented areas can be protected. Streams and lakes can be enhanced by limiting or restricting development, implementing land treatment practices, creating favorable habitat, or other environmental improvements. All these practices can help solve problems such as unsatisfied recreation demands, flooding, water pollution, erosion and sedimentation, and wildlife habitat destruction.

Corridors may be established in several ways. Zoning, access easements, government purchase, and tax incentives are a few possibilities. The method used is determined by funds available and the desires of the local people affected.

A body of water and its associated land make up the environmental corridor. Size is determined by needs of the area – recreation, park and historical site protection – desires of the local people, or other considerations peculiar to an area. In areas where shore land protection is the objective, 300 feet for streams and 1,000 feet for lakes should be maintained. In other areas, such as a park, corridors extending 1/2 mile or more in width may be appropriate.

A section of a stream or lake can best be protected by including the entire reach of water. Upstream activities greatly affect the downstream ecosystem, as is exemplified by industrial pollution. However, entire stream inclusion is impractical in most situations, leaving planning decisions requiring careful individual considerations.

The Minnesota River Basin lends itself to the development of environmental corridors. Recreation demands are increasing, flooding is prevalent, and people have expressed the desire for preservation of waterways in the area.

Careful consideration has been given to all the factors of the corridor concept in choosing areas in the river basin for corridors. Table VII-1 lists potential areas for environmental corridors with establishment factors listed in Table VII-2. The potential environmental corridor map (Figure VII-2) shows the location of these areas.

The areas listed in Table VII-1 are not absolute. The local people should determine their needs and examine the potential corridors thoroughly. Establishment procedures should begin only after the need is documented by the people affected. Through a cooperative effort of local, state, and federal planners; the lakes, rivers and streams of southern Minnesota can be used in the most productive manner to best satisfy the needs and wants of the public. (See Figure VII-2.)

3. **Accelerated Conservation Land Treatment**

One alternative to reduce water and related land resource problems is accelerated installation of conservation land treatment measures. Land treatment is the basic element in resource planning. These measures protect and improve the soil and water resources and at the same time provide the highest feasible degree of runoff retardation, sediment control, and water management. Their effectiveness in reducing runoff, erosion, and sedimentation makes it imperative that they be included as an integral part of all resource conservation projects. Major benefits as a result of land treatment would be in the reduction of soil loss to erosion and the reduction of sediment to streams. Reduction of actual flooding will be minor although the water intake is increased.

TABLE VII-1. POTENTIAL ENVIRONMENTAL CORRIDORS DESIGNATIONS

	Corridor Name	Location
I-1	Blue Earth River	Highway 30 to Minnesota River
I-2	Whetstone River	Pearch Creek to Blue Earth River
I-3	Blue Earth River	Iowa to Elm Creek
I-4	East Branch Blue Earth River	5 miles upstream from Blue Earth River
I-5	Maple River	Minnesota Lake to Highway 30
I-6	Laura Lake	Laura Lake to Maple River
I-7	Cobb River	Freeborn Lake to County Line
I-8	Lake Elvsian	Lake Elysian to Buffalo Lake
I-9	Madison Lake	Madison Lake to LeSueur River
I-10	Fairmont Chain of Lakes	Iowa to Elm Creek
II-1	Cottonwood River	Sleepy Eye Creek to Minnesota River
II-2	Redwood River	7 miles upstream from Minnesota River
II-3	Redwood River	Highway 23 and 91 to 1 mile north of Marshall
II-4	Yellow Medicine River	Highway 274 to Minnesota River
III-1	Chippewa River	12 miles north in Stevens County to 5 miles south in Douglas County
III-2	Lake Minnewaska	Lake Minnewaska to Chippewa River
III-3	Shakopee Lake	Shakopee Lake
III-4	Chippewa River	5 miles upstream from Minnesota River
IV-1	Carver Creek	Lake Waconia to Minnesota River
IV-2	Sand Creek	5 miles upstream from Minnesota River
IV-3	High Island Creek	Bakers Lake to Arlington
IV-4	LeSueur Creek-Forest Prairie Creek	4 miles upstream from Minnesota River
IV-5	Swan Lake	Swan Lake to the Minnesota River
IV-6	Middle Lake	Middle Lake to Swan Lake Corridor
V-1	Minnesota River	LeSueur to Ft. Snelling
V-2	Minnesota River	Upper Sioux Agency State Park to LeSueur
V-3	Minnesota River	Lac Qui Parle Lake to Montevideo
V-4	Minnesota River	Big Stone Lake

Acres needing conservation land treatment are discussed in Chapter V – Conservation Management Systems.

4. Other Measures

There are many other alternatives that should be considered when considering basin-wide solutions. These will not be discussed here, but more information can be obtained by contacting the Soil Conservation Service. They are: Zoning Ordinances, National Flood Insurance, Flood Proofing, Open Space Acquisition Programs, Sanitary Regulations, fifteen year accelerated soil survey. Chapter VIII provides some information on these alternatives.

B. STRUCTURAL MEASURES

Structural measures may be constructed for the purpose of flood water retardation, land stabilization, or to provide for drainage.

Works of improvement for flood prevention consist of land treatment measures and structural measures that produce direct measurable flood prevention benefits to groups of landowners, communities, and to the general public. Because of their size and cost, individual landowners generally would not install them on their land even with the form of assistance available through national conservation programs. These measures ordinarily require group action for their installation and group benefits for their economic justification.

TAVLE VII-2. ENVIRONMENTAL CORRIDOR ESTABLISHMENT FACTORS

Corridor	Park	Campground	Historical Site	Trails	Development, Protection	Flooding	Water[1] Quality
I-1	X	X	X				
I-2							
I-3							X
I-4							X
I-5					X		
I-6					X		
I-7					X		X
I-8					X		
I-9				X	X		X
I-10		X			X		X
II-1	X	X		X			
II-2		X					X
II-3	X	X					X
II-4	X		X				
III-1					X	X	X
III-2					X	X	
III-3					X		X
III-4		X		X		X	X
IV-1					X		X
IV-2		X		X		X	
IV-3					X	X	X
IV-4				X			X
IV-5					X		
IV-6					X		
V-1	X	X	X	X		X	X
V-2	X	X	X	X	X	X	X
V-3	X	X	X	X	X		X
V-4	X	X		X	X		X

[1]X indicates water quality problem exists and corridors will aid in correcting problem.

Land stabilization measures are installed and maintained to prevent land destruction or the production of damaging sediment. They include measures for grade stabilization, gully stabilization, streambank stabilization, and the establishment, development, or improvement of inter-farm or subwatershed waterways serving groups of farms.

Water flow control measures are installed and maintained to control damaging water flows and water borne sediment. They include floodwater retarding structures; clearing, straightening, and enlarging stream channel; levees and dikes; floodways, and floodwater diversions.

Structural measures for drainage are installed and maintained to serve groups of landowners. They are not generally installed by individual landowners becasue of the size and cost. However, providing an outlet is available, there are on-farm practices that can be installed by individuals. Drainage measures include the construction or rehabilitation and improvement of natural channels. The drains may have gravity outlets or may convey drainage water to pumping plants for disposal.

C. SPECIFIC INVESTIGATIONS

A combination of structural and non-structural measures were used to determine solutions to specific areas identified by the Policy Committee and the local people. Following is a summary of these specific investigations (also see Figure VII-1).

1. Study Area I – Blue Earth Basin

a. South Fork Watonwan River

A watershed evaluation was done on the South Fork of Watonwan River to investigate the problems of erosion and sediment, flooding, lack of recreational opportunities, and insufficient depth in School and Irish Lake to support desirable fish populations.

To solve the problems of erosion and sediment, an accelerated program of needed land treatment is recommended.

Potential sites for reservoirs were located, but generally the capacities are limited. Eight structure sites were studied and five have adequate storage for flood prevention, but only one could provide additional volume for multiple purpose use. That site would conflict with the present use as a state wildlife area. The effects of several combinations of single purpose flood retarding structures were determined. The two floodwater retarding structures that are economically feasible are located on the South Fork Watonwan River and on the Bingham Lake Branch. Average annual benefits that will accrue to these structures are $78,915; reduction of damages due to floodwater are $63,545; reduction of downstream sediment damages are $540; more intensive land use benefits are $6,180; changed land use benefits are $1,480 and; local secondary benefits are $7,170.

Annual cost incurred for these benefits is estimated to be $63,040. When this cost is compared with average annual benefits, a benefit cost ratio of 1.3:1 is realized.

Structure sites were investigated which utilized both School Lake and Irish Lake as part of the storage area. Neither are justified for flood prevention. Since Irish Lake has a total drainage area of 96 square miles, it is doubtful that a structure to provide additional depth for fish as recreation would be practical on this lake.

School Lake has a drainage area of 1.6 square miles. It's water level could be raised to provide additional depth for recreation if parts of the flow to Bingham Lake Branch were diverted into the lake. The present drainage area to lake area ratio is only 7.4:1, which would not normally provide a dependable water supply for beneficial use. This possibility was not investigated in detail.

A local proposal which has merit is the acquisition of the wooded valley along the lower reaches of the South Fork Watonwan River for public use. It could be maintained in its natural state, developed for recreation, or some combination of both.

b. Dutch Creek

Problems in this watershed area are sediment yield to the lakes in Fairmont, and land treatment needs.

The City of Fairmont has five lakes within the city limits. These lakes are used as a source of municipal water, and are the core of the municipal park system. It is believed that sediment enters Hall Lake, one of the five lakes, by way of Dutch Creek.

To solve the problem of sediment yield, an accelerated land treatment program and a structural program consisting of a sediment control dam near the outlet of Dutch Creek was investigated. The structure would be a high earth fill dam. Sediment storage need was estimated to be 495 acre feet. The cost estimated for this structure was approximately $600,000.

The installation of the sediment dam proved to be economically unfeasible. Installation of an accelerated land treatment program will greatly reduce the sediment load to the lakes.

c. Maple River Watershed

The Blue Earth Policy Committee (Study Area I) desired information concerning: (1) the management of an existing gated diversion structure designed to divert water from the Maple River into Minnesota Lake; and (2) a specific proposal for works of improvement that would alleviate flooding along the Maple River and improve Minnesota Lake for recreational use.

Two of the alternatives explored were:

1) Provide enough depth in the east end of Minnesota Lake to sustain game fish. It was felt that this could best be accomplished by first draining the lake and then excavating with conventional earth-moving equipment rather than dredging. The excavated material would be used to build a dam across the lake.

2) Lower the lake outlet structure so that the lake west of the dam would have storage available for floodwater and enlarge the diversion structure and channel to provide capacity to divert a two-year frequency flood into the west lake and thus reduce flooding on the Maple River. Enlarge the lake outlet structure as necessary so that the two-year frequency flood would not cause the lake to rise appreciably more than its present elevation of 1034.1 mean sea level.

Although Minnesota Lake could provide excellent flood storage, the diversion is not an effective mean of providing flood protection for the Maple River, nor would it significantly provide for better drainage of the tributary areas.

For the first alternative, lake sizes of 332, 600 and 800 acres were evaluated as to cost and benefits. Average annual costs were $34,000, $60,000 and $78,000, respectively. The value of a fisherman day would have to be from $2.60 to $2.70 in order to have a favorable benefit-cost ratio for the three sizes of lakes studied. Although no specific value is placed on a day of fishing, PL-566 would allow a value of $1.00 per fisherman day in computing benefits for fishing if minimum basic facilities are provided.

For the second alternative, the estimated annual cost of providing the necessary works of improvement to divert the two year frequency flood is approximately $24,000. The estimated average annual damage in the ten mile damaged area of the Maple River is $63,000. To have a favorable benefit-cost ratio, damages would have to be reduced by 38 percent in the entire damage area. The diversion could only provide this percent damage reduction in the upper two miles of the damaged area.

2. Study Area II – Upper Minnesota River Subbasin

Major problems identified in Study Area II are flooding and impaired drainage on 300,000 acres. Other problems associated with these two problems are: pollution, erosion, and sedimentation.

These problems are associated with five principal tributaries that enter the Minnesota River from the south between Big Stone Lake and New Ulm. These tributaries are:

Tributaries	Drainage Area (Acres)
Yellow Bank River	294,080
Lac Qui Parle River	670,912
Yellow Medicine River	427,328
Redwood River	355,584
Big Cottonwood River	275,776

These tributaries must be considered jointly because of the nature of the problem.

The flooding on these tributaries are unique in that flooding and excessive runoff in a given watershed can result in flooding on other watersheds, a process referred to as "crossover flooding".

To solve these problems, three alternatives were considered:

a. The first alternative considered was the without project or present condition. Flooding occurs on 300,000 acres and causes average annual damages of $5,747,000. These damages will continue to occur in the future under this "no action" alternative.

b. The second alternative considered is a non-structural program of abandoning the 5-year floodway to grass and wildlife areas. This is a relatively new concept referred to as Environmental Corridor. The ideals and potentials of this concept are explained on page VII-1 of this chapter.

   To implement this alternative, a total of 227,000 acres would be needed for the floodways with 152,000 acres of cropland returned to grassland. Annual income foregone is $17,604,000. This results from the conversion of cropland to grassland.

c. The third alternative is a program of 81 floodwater retarding structures and ten miles of levees. This will provide flood damage reduction benefits of $2,591,000. The cost of this alternative is $2,647,000. The benefit cost ratio is approximately 1:1. Remaining average annual damages in the basin are estimated to be $3,156,000.

A separate report entitled *Water Resource Evaluation* is available on this area and can be obtained from the Soil Conservation Service's River Basin Office.

3. Study Area III – Minnesota River Headwaters Subbasin

Problems recognized in this study area are flooding, drainage, sediment and erosion, and associated problems of road and bridge damages. These problems exist in two major watersheds – Lower Pomme De Terre and Holloway Creek.

a. Pomme De Terre

The Lower Pomme De Terre Watershed has a drainage area of 255,400 acres. The Upper Pomme De Terre has a drainage area of 298,900 acres which gives a total drainage area of 554,300 acres at the point where Pomme De Terre River enters the Marsh Lake Reservoir near Appleton.

To solve the problems associated with the Pomme De Terre, five alternatives were considered.

1) A series of floodwater retarding structures. Significant flood prevention from this alternative does not appear feasible. The tributary flood plains are narrow and provide little storage. The main Pomme De Terre would still have so much uncontrolled drainage area contributing to peak flows that little damage reduction would be attained.

2) A dam upstream from Appleton on the Pomme De Terre Main stem. This would be a Corps of Engineers-sized project with a drainage area of over 512,000 acres.

   This alternative would practically eliminate flooding on the Pomme De Terre downstream from the dam and reduction of sediment into Marsh Lake would be accomplished. However, the project, at this time, is economically unfeasible. The dam would inundate the flood plain for approximately 10 miles upstream and will cause adverse environmental impacts.

3) Channel improvement consisting mainly of clearing and snagging. This alternative would probably be economically feasible in a few selected areas, but would have little overall effects on the major problems.

4) Levees along the main stem in Swift County. Field examination indicated agricultural flooding problems on 1,350 acres in a 7 mile stretch of river in Moyer Township in Swift County. Leveeing of the entire area does not appear feasible, because to provide enough capacity to handle runoff from the large drainage area, would require most of the 1,350 acres that is supposed to be protected. Some localized levees on parts of the area may be feasible; however, soil stability with high stages and long duration of flow will be a problem to contend with.

5) Land treatment to control wind and water erosion. A land treatment program to control erosion is highly feasible, however, it will do very little to control the flooding problem.

b. Holloway Creek

Holloway Creek is located in Swift County and has a drainage area of 23,000 acres. The major problems are lack of adequate outlets for drainage, flooding of agricultural areas on the main channel and primary tributaries, road and bridge, and erosion damage.

The potential for solving these problems is limited by topography. The watershed does not have an area suitable for reservoir storage.

Three basic alternatives were considered to solve these problems. They are:

1) An extensive land treatment program. This alternative would reduce erosion but have little effect on flooding and would not provide the needed drainage outlets.

2) An all channel project generally following the present channel course. This alternative would provide for seeding, fencing, and land treatment as required along the channel. Since the existing wildlife habitat in the watershed is limited to the woodland along the channel, this alternative will have adverse effects on the limited wildlife in the watershed.

3) A limited channel project with associated measures designed to improve wildlife habitat and an extensive land treatment and conservation cropping program to minimize erosion and sedimentation. This proposed channel would basically follow the present channel alignment. This alternative is economically feasible and would reduce the adverse affects to the wildlife habitat. Average annual cost for this proposal is estimated to be $69,100. Benefits derived are: $95,000 from reduction of crop and pasture damages, $16,070 for other agriculture damages, $2,580 to roads and bridges, and $11,360 from indirect damages. The benefit cost ratio realized is 1.8:1.

4. Study Area IV – Lower Minnesota River Subbasin

a. High Island Creek

Major problems are periodic flooding and impaired agricultural drainage in the middle third of the High Island Creek Watershed. Other problems are sediment, erosion, and minor stream pollution from urban and industrial effluent.

The High Island Creek Watershed is located in Renville, McLeon and Sibley Counties and has a drainage area of 150,000 acres. Eighty-five percent of the watershed is cropped, with corn and soybeans being the major crops. The flood plain width varies from 200 yards to a quarter-mile and includes numerous types II, III and IV wetlands.

To solve the watershed problems, two alternatives were employed. They are:

1) Installation of a large reservoir on the main stem in the lower part of the watershed; however, most of the benefits would be for recreation. This structure would not reduce flood damage or improve drainage outlets in the major problem area. This structure would also inundate about 200 acres of land, most of which is pasture and forest.

2) A system of channels are physically and economically feasible. However, the many Type III and some Type IV wetlands that exist in the flood plain would be adversely affected by channel modifications.

b. East St. Peter, St. Peter

The community of East St. Peter, located entirely within the 100-year flood plain, is subject to severe flooding from the Minnesota River. An existing emergency levee does not provide protection from the 100-year Minnesota River flood at the site. Included in the flood plain are five homes, eight commercial buildings, four tank storage facilities, two concrete ready mix plants, one grain elevator and twelve storage buildings.

In St. Peter, the homes and businesses follow a bench approximated by the 760-foot contour (the approximate elevation of the 100-year flood). Elevations indicate that some basement flooding can occur along the river. Damages can also occur to the St. Peter sewage ponds, located north of East St. Peter in the 100-year flood plain.

The average annual flood damages for East St. Peter and St. Peter are estimated to be $112,000.

The plan selected to meet the water and related land resource needs of St. Peter-East St. Peter is a combination of evacuation, flood proofing and flood plain regulation with flood insurance available for structures where other flood damage reduction alternatives are not feasible.

Detail information on the selected plan are contained in the St. Paul District, Corps of Engineers publication, *Minnesota River at St. Peter-East St. Peter, Minnesota _ Detailed Project Report for Flood Control — March 1975.*

c. Chaska

Water resource problems in the Chaska Creek and East Creek Watersheds of the Minnesota River Basin are the need for reduction of urban flooding, improvement of water quality, and enhancement of recreation and fish and wildlife. The most critical identified need is for reduction of flood water damages.

The flood plain at Chaska consists of approximately 390 acres behind the existing Minnesota River levee and along Chaska and East Creeks. Over 540 residences, 47 businesses and industries, three public buildings, the city's water supply and sanitary system, streets, roads, and public utilities are directly affected by flooding of the two creeks and the Minnesota River.

To solve the flooding problems the following alternatives were considered:

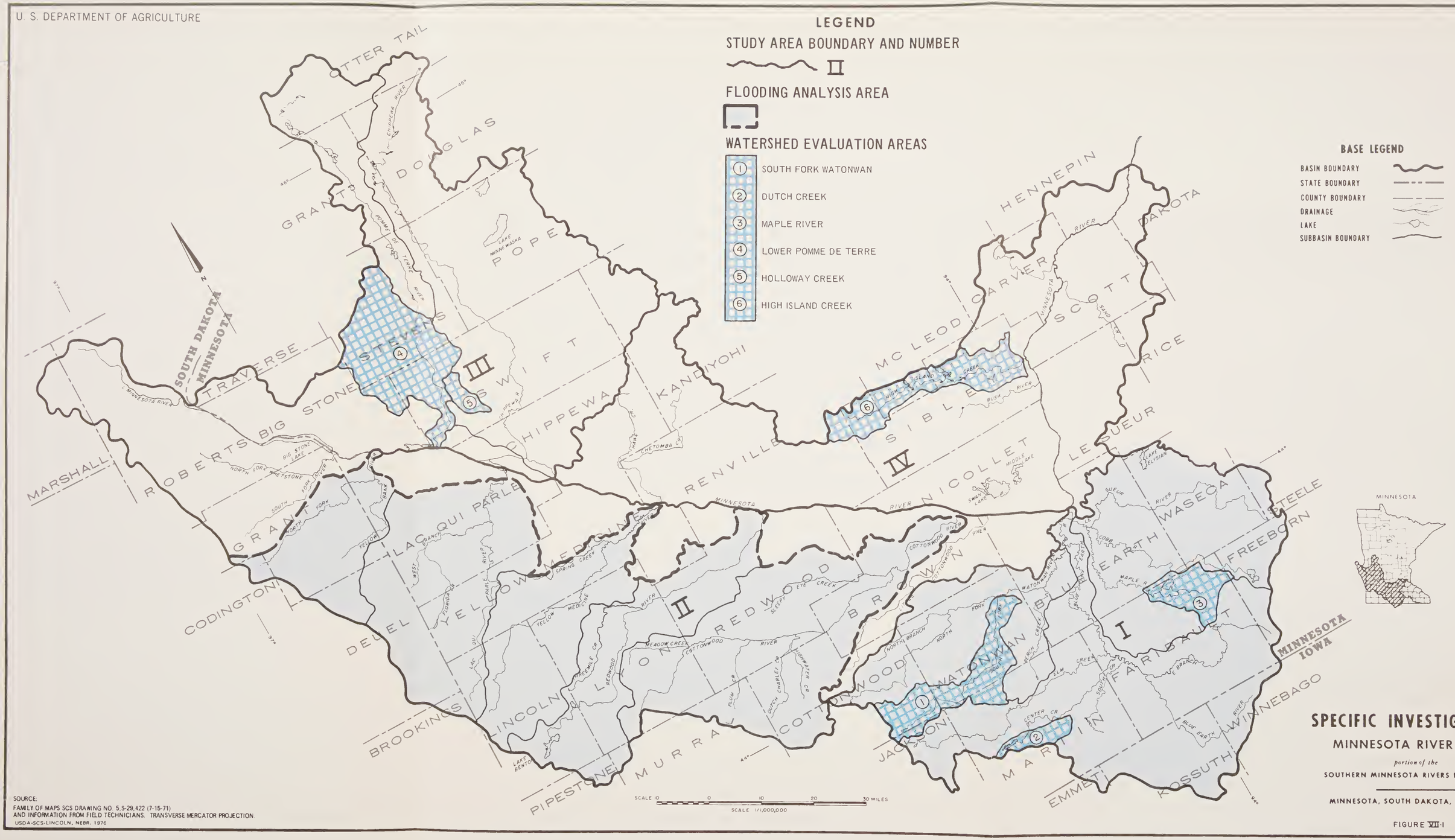
1. Flood bypass channels for East and Chaska Creeks
2. Large reservoirs at two sites on the creeks
3. Channel improvement for the existing streams
4. Levees along the Minnesota River, and
5. Combinations of these measures.

The alternative selected is one that bypass flood flows from East and Chaska Creeks around heavily developed areas of Chaska, upgrading and extending the emergency levee, and installing adequate interior drainage facilities behind the levee.

The average annual cost for the installation of this alternative is $579,000. Average annual benefits are $771,000. When benefits are compared to cost, a benefit cost ratio of 1.3:1 is realized.

Detailed information on the problems in Chaska is contained in the St. Paul District, Corps of Engineers report *Feasibility Report for Flood Control-Minnesota River at Chaska, Minnesota.*

U. S. DEPARTMENT OF AGRICULTURE



SOURCE:
FAMILY OF MAPS SCS DRAWING NO. 5-S-29,422 (7-15-71)
AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.
USDA-SCS-LINCOLN, NEBR. 1976

SPECIFIC INVESTIGATIONS

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE VII-1

4-14-76
5,0-35,642

U. S. DEPARTMENT OF AGRICULTURE

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT

LEGEND

- ENVIRONMENTAL CORRIDOR
- STATE PARK
- CAMPSITE
- HISTORICAL SITE
- STATE TRAILS
  - APPROVED
  - POTENTIAL

POTENTIAL ENVIRONMENTAL CORRIDORS

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE VII-2

3-23-76

5,S-35,615

AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.

USDA-SCS-LINCOLN, NEBR. 1976

CHAPTER VIII

THE BASIN PLAN

VIII – THE BASIN PLAN

The Southern Minnesota River Basin Commission's enabling legislation clearly highlights the emphasis and importance placed on the problems recognized in the basin. Therefore, the objective of the Commission has been to investigate all water and related land resource problems, balance their seriousness and basin-wide impact, seek local citizen reaction and participation, and develop a plan based on basin needs and economic feasibility.

A. EROSION AND SEDIMENT RECOMMENDATIONS

Measures to eliminate basin-wide erosion and sedimentation are virtually impossible to implement. By the very nature of the problem it would become an extremely costly and complex undertaking. Due to the pattern of land ownership in the basin, limited benefits from total reduction of erosion, and the very nature of the weathering process, the Commission supports the following recommendations.

Erosion and Sedimentation Recommendation #1

Landowners should be encouraged to continue to apply wise management practices on agricultural land and, in many cases, at an accelerated rate. This can be complemented by expanding state financial participation in placing conservation practices on the land, development of a state plan for conservation of soil and water resources, and expand education in the need for soil and water conservation practices in the state.

Justification:

There are 10,012,000 acres of agricultural land in the basin of which 82 percent is devoted to crop production. As a result of this, the greatest extent of gross soil erosion is attributed to the present land use. Based on the priority placed on agricultural production, landowners must initiate and maintain practices which reduce soil loss. Practices that can be used are: annual cover, crop residue, minimum tillage, crop rotation, contour farming, stripcropping, terraces, and diversions.

Erosion and Sedimentation Recommendation #2

Where the erosion hazard of cropland cannot be reduced to a tolerable level by treatments, the alternative is to change the land use to permanent cover, either grass or trees. It is also recommended that gully and streambank erosion should be treated wherever practicable and feasible. Possible areas for cost sharing assistance are the State Soil and Water Conservation Board and Resource Conservation and Development, where applicable.

Erosion and Sedimentation Recommendation #3

The legislature should support and fund the proposed 15 year accelerated soil survey. The Legislative Commission on Minnesota Resources is also making recommendations in this area.

Justification:

All lands should be treated according to its needs and used in accordance with its capabilities. By completing a detailed soil survey, proper use of the land can be made that is based according to its capabilities, rather than desired use. Once a detailed soil survey is finished, wise management practices coupled with proper crop placement, an allowable soil loss can be determined that does not reduce the lands productivity.

B. FLOODING RECOMMENDATIONS

To study the flooding problems of the Minnesota Rivers Basin, the basin was separated into four subbasins. The Commission recommends that the following studies be implemented.

1. Blue Earth River – Study Area I

For the Blue Earth River Basin, two structural programs have been selected that offer partial relief to individual flooding problems. The project areas are located on the South Fork Watonwan River and the Minnesota River and its tributaries at Mankato, North Mankato and LeHillier.

Application has been made by local sponsors for a PL-566 project on the South Fork Watonwan River. The local sponsors should continue to seek assistance from the Soil Conservation Service under PL-566.

The Corps of Engineers under the authority provided by the Flood Control Act of 1958 (Public Law 85-500), is constructing a Federal Flood Control Project on the Minnesota River and its tributaries at Mankato, North Mankato and LeHillier. Features of this project will provide flood protection for the three localities. To implement this plan of protection, two-phase construction is proposed with first-phase construction currently underway. When completed, it will provide protection at the Main Street Bridge from a flood which is equaled or exceeded approximately once in 80 years.

It has been determined that, due to a limited BC ratio and major local opposition, phase-two construction will be limited to raising roads and enlarging bridges that presently restrict the Minnesota Rivers flood flow.

2. Upper Minnesota River Subbasin – Study Area II

Local residents have been trying for years to find a solution to the areas flooding problems. Successful solutions have been found in some isolated areas, but for the most part remedies have been limited and few federal, state and local studies have resulted in implementation projects.

Numerous meetings with local people were held throughout the course of the Type 4 investigation. The local viewpoint is a preference for structural rather than non-structural solutions. For this reason, as well as economic feasibility, the Commission proposes a structural program of 81 floodwater retarding structures and 10.1 miles of levees. By implementing the upstream reservoir and levee system, the crossover flooding problem will be stopped, a balanced level of flood protection met, and further opportunity for flood damage reduction by both structural and non-structural measures provided.

The Commission recommends that the joint study by the Department of the Army and the Department of Agriculture, authorized by Congress under PL 87-639, be used to aid in solving the problems in Study Area II.

3. Minnesota River Headwaters Subbasin – Study Area III

On the whole, flooding in this study area ranked low when compared to the other resource problems. However, the study did identify two watersheds that would provide flood reduction benefits if projects were carried out on them. These projects are the Holloway Creek Watershed and the Lower Pomme De Terre.

In the Holloway Creek Watershed, the physical potential for meeting watershed needs is limited by topography in that the area is unsuitable for reservoir storage. The Commission, therefore, recommends an 11.7 mile channel project, generally following the present stream bed, and associated land treatment.

Residents of the Lower Pomme De Terre Watershed have applied for SCS assistance to help alleviate the flooding problems. The Basin Commission's conclusion and recommendation is to carry out clearing and snagging of the channel in a few selected areas. The Commission recommends that the local sponsors seek assistance from the Resource Conservation and Development program to solve the problems in the Holloway Creek and Lower Pomme De Terre Watershed.

4. Lower Minnesota River Subbasin – Study Area IV

Unlike the previous three subbasins, this area's major flooding problems exist in towns located on the mainstem of the Minnesota River. Economically feasible projects have been identified by the United States Army Corps of Engineers for the towns of St. Peter and Chaska.

The Commission recommends implementation of the proposed flood control projects and offers the following brief description of the anticipated measures that can best alleviate the flood damage problems.

St. Peter and East St. Peter:

Flooding in the St. Peter area is attributable to high stages on the Minnesota River. The area subject to flooding within the St. Peter study area includes all of East St. Peter and the eastern portion of St. Peter along the left bank of the Minnesota River.

The selected plan, developed by the Corps of Engineers, that most satisfactorily meets the economic efficiency objectives and provides the least impairment to environmental quality and social well-being is:

a. Evacuation and removal of all residential and business structures within the East St. Peter area confined by the existing emergency levee except for flood proofing of the railroad depot.

b. Flood insurance available as an option for all other flood prone sections within the study area.

c. Flood plain zoning ordinances for the areas which are in compliance with state flood plain regulation requirements.

d. Continuation of a flood warning system for the Minnesota River to allow time for appropriate actions to minimize remaining flood damages.

Total average annual costs are estimated to be $67,600 and total average annual benefits are projected as $78,700 – both at January 1975 price levels. The local sponsor has not reached a decision on its willingness or ability to furnish the requirements of local cooperation and hence no action is currently being taken on the proposed project.

Chaska:

Flooding in Chaska is caused by Chaska Creek, East Creek, and the Minnesota River. The most critical need is for the reduction of flood damages to personal and public property and the avoidance of human hardship, suffering, and loss of life.

The flood plain at Chaska consists of approximately 390 acres behind the existing Minnesota River levee and along Chaska and East Creeks. Over 540 residences, 47 businesses and industries, streets, roads and public utilities are directly affected by flooding of the two creeks and the Minnesota River. Damage estimates of 4 million dollars would result from an intermediate regional flood under 1973 conditions.

An intensive investigation was conducted in cooperation with local, state and federal officials which led to development of a flood plain management plan which incorporates both non-structural and structural measures. The Commission supports the plan recommended by the Army Corps of Engineers which consists of diversion channel, flood bypass channel, ungraded levee, and new levee and associated works. The feasibility report for this plan is currently under review in Washington.

5. Basin-Wide-Recommendations – Flood Plain Management

The localized flood control projects that the Commission is recommending offer considerable protection to the individual project areas, but do very little to substantially reduce main stem flooding. The Army Corps of Engineers submitted, in 1966, a *Phase I Feasibility Report for Flood Control on the Minnesota River.* The report identified seven potential reservoirs designed to control mainstem flooding.

These reservoirs would, no doubt, reduce flood peaks, but because of local and state opposition, proposed loss of the specific areas limited wildlife habitat and doubtful economic feasibility, the projects cannot be recommended for construction.

Faced with only a few feasible structural alternatives, the Commission supports the following non-structural programs that will assist in reducing flood damage costs.

The Commission recommends total basin-wide adoption, enforcement, and administration of sound flood plain management programs. This is in support of Minnesota Statutes Chapter 104 (the Flood Plain Management Act). Further, that local governmental units should use the Minnesota Department of Natural Resources' Flood Plain Management Staff for review assistance and other statutory responsibilities.

By adopting and enforcing flood plain regulations, the local units of government would provide for maximum allowable use and development of flood hazard areas without unduly increasing the threat to public health, safety, and welfare.

a. Zoning Ordinances

Zoning is concerned primarily with the incompatible uses of land. Zoning ordinances should be adopted that contain flood plain regulations, divide flood plain areas into floodway and flood fringe areas, and apply reasonable regulations to both.

To meet flood management goals, as well as natures needs to convey floodwaters, flood plain regulations should tightly control development in the flood plains. Debris, fill, buildings, roads, bridges, and other uses which would individually or collectively restrict flood flow or would be seriously damaged by floods, should be prohibited in the flood plains. To meet the needs of man, and development in outer fringe areas, dwellings and essential services must be placed on fill or otherwise be protected to the regulatory flood elevation. This prevents urban blight, unsanitary conditions, loss of life, economic losses, and social disruption that accompany uncontrolled flood plain uses.

b. Subdivision Regulations

Subdivision regulations should be used to guide the process of land division to assure that lots meet buyer needs without putting a burden upon a community to supply emergency public protection.

Justification:

Subdivision regulations can reduce flood losses by:

1) Prohibiting the subdivision of lands subject to serious flooding unless hazards are overcome;

2) Requiring the designation of flood hazard areas on subdivision plats and the insertion of restrictions on purchase deeds to control lands unsuitable for dwellings and other uses;

3) Prohibiting encroachment in floodway areas by fill or structure;

4) Requiring that a portion of each lot be filled or otherwise protected to provide a safe building site with adequate areas for waste disposal (if on-site facilities are used) at an elevation above flood heights; and

5) Requiring the installation of streets, sewer, water, and other facilities which have been flood-proofed, elevated or otherwise protected against floods.

c. Building Codes

A building code is a set of regulations adopted by a local governing body setting both standards for the construction of buildings and other structures for the purpose of protecting the health, safety, and general welfare of the public. In a flood plain management context, such regulations establish the special design and construction provisions that should be required for buildings, structures, and support facilities that are, or may be, subject to flooding. These provisions may include: anchorage of structures to prevent flotation, installation of watertight barriers over openings, reinforcement of walls to resist water pressures, use of materials to reduce wall seepage, construction or modification of water supply and waste disposal systems to prevent entry of floodwaters, placement of essential utilities above the flood elevation, and installation of pumping facilities for internal and subsurface drainage.

Justification:

Where existing streets or utilities are at locations which make the construction of buildings or structures impractical, building code provisions can effectively reduce flood damages to buildings or structures located below the required flood protection elevation. This is done only if minimum standards are adhered to.

In 1971, the Minnesota Legislature adopted an act providing for a state building code (Minnesota Statutes Chapter 16.85) which requires any county or city which had previously enacted a building code or subsequently enacts a code must adopt the state code.

d. National Flood Insurance

Under the National Flood Insurance Act of 1968 (Public Law 90-448), as amended, the Secretary of Housing and Urban Development (HUD) is authorized to carry out a National Flood Insurance Program. The program was established to make flood insurance available for losses due to inundation by floodwaters from the overflow of streams, river, inland waters, or a rapid accumulation of runoff of surface waters from any source.

Insurance is sold to property owners or renters only after the locality has applied to HUD and expressed an interest in being declared eligible for flood insurance and has adopted land use and control measures for flood hazard areas consistent with criteria set forth in the HUD regulations.

Justification:

Under Minnesota Statutes 104.08, all local governmental units subject to recurrent flooding are required to participate in the National Flood Insurance Program.

e. Other Measures

Land use controls such as zoning, subdivision regulations, and building codes can play an important role in flood plain management. However, in order for these measures to be effective, it is important that local units of government take action to implement other programs and measures to supplement these controls. A few possible measures are: (1) open space land acquisition programs; (2) urban renewal; (3) preferential tax assessment; (4) flood proofing of existing structures; and (5) public policy governing the construction of public facilities such as bridges, streets, and utilities in the flood-prone areas.

Flood warning, forecasting, fighting, and emergency evacuation plans can also be used as tools for flood damage reduction. None of these measures are total answers, but when integrated in an overall plan they become very effective in reducing flood damages.

C. DRAINAGE RECOMMENDATIONS

Drainage of agricultural land has become increasingly controversial during the past six years. Legislation passed during the 1973 session of the Minnesota Legislature brought attention to seriously interrelated problems that exist between Minnesota Statutes, Chapters 105 and 106. Some of these conflicts resolved by the 1976 Legislature by passage of Chapter 83, Laws of 1976. Three essential issues of the new law are as follows:

1. County-by-county mapping and classification of all the public water basins and watercourses in the state.

2. Delegation of control over Class III watercourses to the respective counties.

3. Compensation available to those landowners who have areas classified as public waters and that fall under certain criteria.

It is recognized that with Minnesota's vast supply of natural resources, drainage of some areas should be allowed. Construction of projects has been and will continue to be implemented by local landowners as the desired use of the areas having drainage problems changes.

Drainage Recommendation #1

The Department of Natural Resources shall conduct an all-out effort to complete the public waters classification and mapping procedure. Two years from the date of enactment of Chapter 83, Laws of 1976, is the recommended maximum time period for completion.

Justification:

The Commission believes that control over drainage of agricultural land is best handled by various levels of government. Areas that have statewide significance, as determined by DNR and the respective county, should have DNR control and areas with lesser significance are best handled by county government. To complete the delegation of DNR control over Class III water courses to the counties, the mapping and classification must be completed as quickly as possible.

Drainage Recommendation #2

The legislature should consider assigning the Department of Taxation to work on a compensation formula for lands restricted from drainage. Incentive compensation should be included as a method to assure compliance with future state policies.

Justification:

One of the basic problems inherent to the drainage controversy is the question of economics. Landowners are forced into bringing marginal areas into production so that the tax assessments can be met. An interrelated wetlands program between the Department of Natural Resources and the Department of Taxation could help maintain areas that may otherwise be lost.

D. WATER SUPPLY RECOMMENDATIONS

There does not appear to be a serious water shortage in the basin; however, for those communities that experience periodic problems due to inadequate facilities and distribution systems, the Commission makes the following recommendations:

Water Supply Recommendation #1

The communities of Fairfax, LeSueur, New Ulm, and Marshall should begin seeking additional water supply sources to supplement existing facilities by investigating the feasibility of establishing deep wells. This will allow the communities to meet present and projected peak demands.

Water Supply Recommendation #2

A complete inventory and continuing monitoring system of all the water supply sources should be completed. By developing a thorough knowledge of the basin's water supply quantity and the various demands made on it, a wise management policy can be developed to meet future consumption demands as they are exerted. The Minnesota Legislature should allocate sufficient monies to the Minnesota Geological Survey and the Department of Natural Resources to carry out the inventory and monitoring activities.

E. IRRIGATION RECOMMENDATIONS

Irrigation Recommendation #1

It is recommended that landowners proceed with individual irrigation systems whenever soils, water supply, and favorable cost returns combine to prove practicable.

Irrigation Recommendation #2

The Minnesota Legislature needs to adequately fund a program that establishes basin-wide monitoring and gaging stations data on minimum allowable stream flows, information on climatic influences, and quantitative data on ground water supplies.

F. FOREST LAND RECOMMENDATIONS

The Minnesota Department of Natural Resources Division of Forestry is charged with developing the forest resources of the basin and they should take the lead role in developing the following recommendations.

Forest Land Recommendation #1

A reforestation program should be established that replaced the forests lost to harvest and that maintains proper erosion control.

Forest Land Recommendation #2

Overgrazing of forest land causes severe erosion and often a sedimentation problem. Where these two problems become a critical issue, pasture land management must be implemented. Pasture rotation is recommended, but in cases where steep slopes are involved, livestock should be excluded.

Forest Land Recommendation #3

Forest land should be used for timber production, recreation sites, wildlife habitat, and protection for critical areas. Developing the forests for these uses will provide a better environment in the basin.

G. WATER QUALITY RECOMMENDATIONS

Pollution was mentioned quite frequently as a problem in the basin. The two major sources of water quality problems in the basin are point and nonpoint sources of pollution. In general, point sources of pollution are a pollutant discharging from a specific location such as a pipe, municipal sewage disposal plants, industrial dischargers, and some agricultural feedlots. Nonpoint sources are somewhat harder to identify, but they are typically pollution causes by an activity which allows pollutant materials to enter runoff which flows to surface waters or to the groundwater. The six categories of nonpoint sources generally recognized in Minnesota are: agriculturally related, forestry related, mining related, construction related, disposal of pollutants on land or underground, and hydraulic modifications (such as dredging, impoundments, or channelization).

The Minnesota Pollution Control Agency has responsibility for determining and describing the process by which Minnesota will conduct water quality management planning. As described in Chapter IV, the planning is to fulfill the requirements of Sections 208 and 303 of the Federal Water Pollution Control Act as amended in 1972.

Water Quality Recommendation #1

The Commission recommends that the Minnesota Pollution Control Agency adhere to the time tables set forth by the Federal Water Pollution Control Act Amendments of 1972.

Water Quality Recommendation #2

All attempts to control nonpoint source pollution shall be closely tied into land treatment practices that are implemented in the basin.

Water Quality Recommendation #3

Methods and plans developed to reduce or eliminate pollution in the basin shall be based on inputs and decisions from local planning and policy groups.

H. FISH AND WILDLIFE RECOMMENDATIONS

Wildlife Recommendation #1

The private landowner should be encouraged to maintain habitat that will support wildlife populations.

To accomplish this, the landowner should receive a suitable return on his investment. State and federal programs that offer technical assistance and cost sharing should be promoted. New state programs that offer reduced tax rates for wildlife areas should be developed.

Wildlife Recommendation #2

Where habitat is inundated, drained, or otherwise made unavailable to wildlife, similar habitat should be provided equal to the magnitude of the loss.

Wildlife Recommendation #3

There should be an acceleration of research studies of pesticides, thermal effects, and other pollution problems. This should be done by universities and other agencies concerned with wildlife protection.

Wildlife Recommendation #4

There should be better communication between federal and state conservation agencies and between agencies with varying or conflicting interests to insure that the basin's natural resources remain.

Wildlife Recommendation #5

Essential wildlife areas that are threatened to be lost should be purchased by the Department of Natural Resources and managed for wildlife production.

The purchase of wildlife areas should be based on long-range acquisition plans and implemented as soon as economically feasible.

I. RECREATION RECOMMENDATIONS

The Minnesota Department of Natural Resources, with cooperation of various federal, state, regional and local agencies, has completed a comprehensive outdoor recreation plan for the State of Minnesota. This includes details on existing facilities, regional needs, and deficiencies that will need to be met if recreational demands are to be satisfied.

Recreation Recommendation #1

The appropriate sections of the Minnesota *State Comprehensive Outdoor Recreation Plan — 1974* should be used and its recommendations considered by all agencies contemplating developing outdoor recreational facilities and opportunities.

The Minnesota *State Comprehensive Outdoor Recreation Plan — 1974* has identified deficiencies in available recreation opportunities. From the plans, the Department of Natural Resources has developed and presented to the Minnesota Legislature a proposal outlining a 6-year accelerated acquisition program. The emphasis is placed on lands having the highest priority from the standpoint of recreational demand and management efficiency.

Recreation Recommendation #2

Planning, acquisition, and development programs to increase outdoor recreation opportunities should be accelerated by all governmental agencies in the basin. There should be a concentrated effort to coordinate each governmental units acquisition program. In addition, purchasing programs of the specific governmental agency should reflect its area of authority and the participants drawn from within its legal boundaries.

Recreation Recommendation #3

To supplement acquisition programs, full use should be made of zoning, easements, leasing, deed restrictions, and other land use controls that provide possibilities for recreational opportunities. This should be a coordinated program between the affected local governmental unit and the State Department of Natural Resources.

Recreation Recommendation #4

Environmental corridors concept should be planned as an integral part of water resources development.

Environmental corridors not only form the basis for future recreation development in rural areas, but they can isolate critical hydraulic, topographic, and vegetative features that need to be protected.

Recreation Recommendation #5

Full consideration should be given to the feasibility of developing the following projects on the Minnesota River: the Minnesota Valley National Wildlife Refuge, Minnesota Valley Trail, and including the upper portion of the Minnesota River in the Wild and Scenic Rivers System.

Recreation Recommendation #6

Watershed management, soil conservation practices, and urban runoff retarding practices should be intensified as a means of reducing soil erosion and enabling the basin's water resources to increase their recreational potential.

J. LAND USE RECOMMENDATIONS

Rapid population increase and its potential consequences on the quality of life are aspects of growth that are both novel and pressing today. Recently, people have begun to realize that a growing area uses up its natural resources more rapidly. Vacant land, clean air, and water become increasingly scarce.

Population growth and its consequences can be addressed through a variety of programs by local government. The programs include: land use regulations (zoning, subdivision control, open space and comprehensive planning), regulation of capital projects both public and private, sewer and water programs, transportation, environmental controls, and building and housing codes. Many of these programs have been carried out routinely by local government. Some have not. But a few local governments have handled these programs in a coordinated fashion with their consequences for growth clearly in mind.

With this in mind, there are a number of growth-oriented policies that should be adopted.

Land Use Recommendation #1

Local government is best suited, among all levels of government, for taking the initiative in guiding growth.

Justification:

Local government has the authority to regulate land, water and sewer construction, transportation, and other areas because it provides the major services which influence growth. It also must be considered that the nature of growth problems varies so drastically between localities that any blanket federal or state policies would be unrealistic.

Local control also insures the maximum freedom of choice to pursue any array of living arrangements, services, and controls that best fit the respective citizens' needs. This is not to say there is not a need for federal, state, and regional framework policies which may insure against encroachment on the basic requirement of equal access to resources and the amenities of life.

Land Use Recommendation #2

In order to deal with growth, it is especially important that regional bodies be constituted as umbrella, multijurisdictional organizations which seek to coordinate area development, local policies, and programs that are related to growth and land use on a regional basis.

Justification:

With the increased state activity in land use, particularly in the recreation facilities, roads, natural resources and other state-wide land uses in rural areas, it is especially important that local officials recognize that to maintain a strong role in land use control, they must act in concert at the regional level.

Land Use Recommendation #3

The State of Minnesota should act to protect the overall interests of citizens in the state with regard to land use, conservation of resources, and protection of the environment by the issuance of standards and guidelines for land use development and other aspects of growth.

Justification:

With the increase in the scale of population settlements and the general mobility of population, the necessity for state involvement in land use and growth decisions becomes both inevitable and desirable. The state can set standards and guidelines that relate to the overall needs of the state and in general outline the ways in which the needs are to be met. The state has done this in several areas such as the Pollution Control Agency regulations and Flood Plain and Shoreland Regulations.

Major locational decisions on parks and wilderness areas and other natural assets will have to be made at the state level. The state will continue to become more involved in the regulation of environmental pollution, such as power plant facilities, mining operations, major traffic generation centers, etc., as the U.S. Environmental Protection Agency demands more state action.

Land Use Recommendation #4

State and local tax policy (assessment procedures) should be considered with the recommended land use or regulatory policy and used as a tool to implement desired land use balance.

Justification:

It is inappropriate to develop specific wetland, open space, flood plain, and land use policies without taking into consideration corresponding policies that relate to the value of the property and the taxation of the property. It is the opinion of this Commission that appropriate assessment and taxation policies should be adoped to reduce and balance the impact of state adoped standards and regulations. Therefore, the following policies are suggested.

Land Use Recommendation #5

The State Legislature should develop policies which recognize the potential utility of the land and provides compensation equivalent to that utility.

This type of policy will run contrary to court decisions on the doctrine of public trust, which permits additional state regulation of activities that might harm areas of special public interest. Total restriction of intensive use and land conversion has been sustained without compensation. We submit that if a special public interest is in fact established, then the public should be willing, through direct compensation, indirect income tax benefits and/or property tax benefits, to pay for that utility.

CHAPTER IX

OPPORTUNITIES FOR USDA PROGRAMS AND THE NEED FOR FUTURE DEVELOPMENT PROGRAMS

IX – OPPORTUNITIES FOR USDA PROGRAMS AND THE NEED FOR FUTURE DEVELOPMENT PROGRAMS

Chapter VI lists USDA programs that are available for solving many of the resource problems recognized in the basin. This chapter (Chapter IX) will point out USDA's programs that can be used for implementing some of the Commission's recommendations. Since USDA programs will not solve all problems in the basin, programs needed, but not presently available, will also be discussed.

A. USDA PROGRAMS

1. Public Law 46 – Land Treatment Program

The need for accelerated land treatment has been recognized and recommended in the Commission Plan (Chapter VIII). To implement the recommended accelerated land treatment program, technical and financial assistance is available through the Soil Conservation Service (SCS) and the Agriculture Stabilization and Conservation Service (ASCS), under the Authority of PL-46, to individuals or group of landowners in both rural and urban areas. These available services through PL-46 should serve as a stimulant in implementing the Commission recommendation. These services are also available for the treatment of cropland, streambank, woodland and urban construction sites.

2. Public Law 83-566 – Watershed Project

Under the authority of this law, technical and financial assistance is available to help solve flooding, drainage, sediment, and erosion problems. The Commission has recommended the installation of the South Fork Watonwan River Watershed project in Study Area I. Preliminary investigations indicate that this project meets the basic requirement under PL-566 and is eligible for assistance. PL-566 can be instrumental in implementing this recommendation for flood control.

3. Resource Conservation and Development Projects, PL-87-703

The basin has parts or all of fifteen counties in the WesMin and Hiawatha Valley RC&D Project Area and an application has been made for the Prairie Lake RC&D project in South Dakota. Under the authority of this law, technical and financial assistance is available to eligible sponsors in designated RC&D areas to help install eligible project measures that will improve the economic conditions of local residents. This program can help meet the recreational recommendation and assist in implementing the accelerated land treatment program. Assistance is also available for relief from flood and, with certain restrictions, drainage.

The Commission has recommended the installation of the Holloway Creek and the Lower Pomme De Terre Watershed in Study Area III. Preliminary investigations indicate these two projects meet the basic requirements for installation through the RC&D Program. Therefore, it is recommended that RC&D be considered for project installation.

4. Rural Development Programs

Rural development programs will continue to be available as they have been in the past. The Farmers Home Administration will continue to provide an assortment of loans to individuals and groups for the purpose of resource conservation and environmental improvement. The Federal Extension Service specialists are available to work with individuals, groups, and federal and state agencies to provide technical information relating to soil and water conservation programs and recreation needs and developments.

5. Cooperative State-Federal Forestry Programs

This program is valuable in meeting the need to convert cropland to forest land on those areas which have excessive erosion or are otherwise more suited to the growth of forest products. Also, assistance is available in selecting and implementing recreational areas through use of the environmental corridor concepts or the open space areas.

6. Public Law 87-639

Under this authority, the Secretary of the Army and the Secretary of Agriculture have been directed to make joint investigations and surveys, in accordance with their existing authorities, of watershed areas and prepare joint reports setting forth their recommendations for needed flood prevention measures.

To solve the flooding problems in Study Area II, the Commission has recommended the installation of 81 floodwater retarding structures and 10.1 miles of levees. PL 87-639 has been specifically authorized to conduct investigations to determine the effects and the implementation potentials of this recommendation.

7. Soil Survey – PL 46

In order to implement the Commission land use and tax policy recommendations, it is very important to know the soils capabilities. By using soil survey information, it is possible to determine the land capability and its best use. Soil survey reports have been published for fifteen counties in the basin. By 1984, reports for 12 more counties will be completed (see Figure VI-1).

During the Metro Level B Study, a River Basin Study of the Seven County Twin Cities area, extensive information on the soil landscape was prepared for this seven county area. Four of these counties are located in the basin. They are: Carver, Dakota, Hennepin, and Scott. Two publications, *Interpretations of Soil Landscapes and Geomorphic Regions — Twin Cities Metropolitan Sheet* and *Soil Landscapes and Geomorphic Regions — Twin Cities Metropolitan Area Sheet,* are available from the Agricultural Extension Service, University of Minnesota.

B. FUTURE DEVELOPMENT PROGRAMS

Changing public demands and emphasis are shifting toward programs that will provide for a quality environment in which to live and grow. In developing new public programs, planners and legislators should consider these shifts in values.

It is agreed that new programs are needed in several areas. Details of these programs are not worked out; only the concerned areas are mentioned.

1. Programs should be developed that will provide for greater cost-sharing to individual landowners for the installation of conservation practices that improve resources that provide public benefits. Special emphasis should be given to water quality improvement. Existing programs could be modified to provide for increased cost-sharing.

2. The Resource Conservation and Development program should be expanded to cover more of the basin.

3. Programs are needed that give more attention to the environmental corridor concept and other non-structural measures for solving resource problems. Public acquisition of areas that are unique and provide environmental benefits should be seriously considered.

4. Private land has a great potential for meeting fishing, hunting, and other recreational demands. Programs that provide incentives to open these areas to the public are needed.

5. The Minnesota Legislature created Chapter 83, Laws of 1976, which authorizes various procedures that modifies the public waters and drainage laws of Minnesota. Of specific interest is the authorization of: (1) a county-by-county inventory of waterbasins and watercourses by the Department of Natural Resources and counties, respectively; and (2) the creation of a state water bank program identifying eligible wetlands and specifying rights and obligations of the Commission of Natural Resources and the landowner.

   During the interim year between introduction of the bill and its passage into law, nineteen counties in the Minnesota Rivers Basin participated on a pilot basis, with the DNR, on classifying the public waters of their respective counties. To complete the watercourse inventory, each county requested help from its local SCS District Conservationist. The time spent on the inventory was accounted for by the Type IV River Basin Study funds. The result of the effort enabled those nineteen counties to test the details of the proposed law, gain cooperation with the DNR, and offered them the opportunity to establish a county-state management inventory of the public waters in each county.

   Now that the bill has been signed into law, the rest of the counties in the state can begin the inventory and classification procedures. The results will be county maps showing all the areas needing water permits, extended management authority over the waters in each county, and compensation for certain areas that are classified as public waters.

APPENDIX A

GENERAL SOIL MAP AND GEOMORPHIC SURFACES
MINNESOTA RIVER BASIN

The Minnesota River Basin covers a broad area and contains numerous soils with diverse geomorphic surfaces. Relief in the basin is controlled, in part, by the underlying bedrock and, in part, by thick galcial drift.

The soils of the basin were first grouped on the basis of parent material. This broad grouping was further divided into distinctive geomorphic surfaces. And finally, the soil associations within each geomorphic surface were delineated as shown on the maps with this report. The soil associations and major soils are briefly discussed in the text that follows. Detailed information about the individual soils is available in published soil survey reports or in SCS files.

AREAS DOMINATED BY SOILS FORMED IN LOAMY MATERIAL

These are mostly upland soils formed in loamy glacial till. They range from well drained to very poorly drained soils on till plains and moraines. Native vegetation was dominantly tall-grass prairie; however, hardwood forests occurred in the northeast part of the basin.

1. Coteau Slope (gently sloping till plain with steel scarps)

This area is two to eight miles wide with stepped, nearly level, to gently sloping northeasterly facing slopes. These slopes are crossed at near right angles by stream entrenchments and deeply cut ravines. Local relief is commonly less than 10 feet with most slopes, excluding steep slopes, ranging from 2 to 4 percent and 40 to 100 feet in length.

a. Aastad-Forman-Parnell Association:

Aastad are moderately well to somewhat poorly drained, slightly acid or neutral, nearly level soils on toe slopes or on flats and swales. Forman are well drained, neutral or mildly alkaline, gently sloping soils on knolls and ridge crests. Parnell are very poorly drained, neutral to mildly alkaline soils in depressions and long, winding, low gradient drainageways. Minor soils included are the Buse and Langhei soils on the ravine slopes, Flom soils on flats associated with the Parnell soils, and Lamoure and LaPrairie soils on the stream and ravine bottomland.

Cropland is the principal land use. Intertilled crop acreage decreases toward the west. Pasture is common in and adjacent to the ravines. Erosion from the sloping soils, and wetness on the porrly and very porrly drained soils are the principal limitations to use.

b. Nicollet-Clarion-Webster Association:

Clarion are well drained, slightly to medium acid, gently sloping soils on the higher knolls. Nicollet are moderately well drained to somewhat poorly drained, slightly or medium acid, nearly level soils on low knolls.

Webster are poorly drained, neutral or slightly acid, nearly level soils on broad flats, and narrow drainageways. Minor soils included are Canisteo soils adjacent to or intermingled with Webster soils, Comfrey and Huntsville soils on stream and ravine bottomland, Glencoe soils in depressions and low gradient drainageways, Storden soils on ravine slopes, and Terril soils on foot slopes.

Cropland is the principal land use. Corn and soybeans are the major crops. Pasture is common in and adjacent to the ravines. Erosion on the sloping soils and wetness on poorly and very poorly drained soils are the principal limitations to use.

2. Gently Sloping Ground Moraine

This area consists of aligned narrow crested ridges and unaligned low knolls. The ridges and knolls are on a flat plain with low graident, narrow swales and shallow depressions. Slope crests rise five to ten feet above their base. Most slopes, excluding stream entrenchments and lake depressions, range from 2 to 4 percent and 40 to 100 feet in length. The area is characterized by a lack of natural watercourses.

a. Nicollet-Storden-Canisteo Association:

Nicollet are moderately well drained to somewhat poorly drained, slightly or medium acid, nearly level soils on low knolls. Storden are well drained, calcareous, undulating soils on ridge crests, and convex knolls. Canisteo soils are poorly drained, calcareous, nearly level soils on rims of depressions and in drainageways. Minor soils included are Clarion soils on knolls, Webster soils in broad and narrow drainageways, Comfrey and Huntsville soils on stream and ravine bottomland, Crippin soils adjacent to or intermingled with Nicollet soils, and Glencoe soils in depressions and low gradient drainageways.

Cropland is the principal land use. Corn and soybeans are the major crops. A slight hazard of erosion on sloping soils and wetness on the poorly and very poorly drained minor soils are the principal limitations to use. Special fertility management is needed on calcareous soils.

b. Svea-Hamerly-Vallers Association:

Svea are moderately well drained to somewhat poorly drained, neutral to mildly alkaline, nearly level soils on low knolls. Hamerly are moderately well drained, calcareous, gently sloping soils adjacent to or intermingled with Vallers soils. Vallers are poorly drained, calcareous, nearly level soils on flats. Minor soils included are Barnes and Buse soils on ridge crests and convex knolls, Flom and Winger soils on flats, McIntosh and Tara soils on low convex slopes, and Parnell and Quam soils in depressions and low gradient drainageways.

Cropland is the principal land use. Corn, soybeans, sugarbeets, and sunflowers are the major crops. Wetness on the poorly drained soils is the principal limitation to use. Special fertility management is needed on calcareous soils.

3. Nearly Level Ground Moraine

This area consists of nearly level to gently undulating plains with a few 5 to 10 feet knolls. Drainage is nonintegrated. There are a few outwash and valley train features.

a. Peever-Tonka Association:

Peever are well drained, neutral, nearly level to undulating soils with clayey subsoils on flats and low knolls. Tonka are poorly drained, slightly to medium acid soils with clayey subsoils in closed basins. Minor soils included are the Forman, Hamerly, and Aastad soils on low convex slopes and Vallers soils on flats.

Cropland is the principal use. Wheat, flax, oats, and alfalfa are the main crops. Wetness on poorly drained soils is the principal limitation to use. Management practices are needed to control wind erosion and improve infiltration.

b. Hamerly-Oldham-Parnell Association:

Hamerly are moderately well drained, calcareous, nearly level soils on low convex slopes. Oldham are very poorly drained, calcareous soils in depressions and large sloughs. Parnell are very poorly drained, neutral soils in depressions. Minor soils include Blue Earth in lake basins, Tonka soils in shallow depressions, and Vallers soils on the flats.

Cropland is the principal land use. Corn, soybeans, sugarbeets, and sunflowers are the main crops. Wetness is the principal limitation to use. Special fertility management is needed on calcareous soils.

c. **Hamerly-Winger-Parnell Association:**

Hamerly are moderately well drained, calcareous, nearly level to undulating soils on low convex slopes. Winger are poorly drained, calcareous, nearly level soils on flats. Parnell are very poorly drained, neutral soils in depressions. Minor soils included are Blue Earth soils in lake basins, McIntosh soils on convex slopes, Tonka soils in shallow depressions, and Vallers soils on the flats.

Cropland is the principal land use. Corn, soybeans, sugarbeets, and sunflowers are the main crops. Wetness is the principal limitation to use. Special fertility management is needed on calcareous soils.

d. **Webster-Nicollet-Glencoe Association:**

Webster are poorly drained, neutral to slightly acide, nearly level soils on broad flats and narrow drainageways. Nicollet are moderately well drained to somewhat poorly drained, slightly or medium acide, nearly level soils on low knolls. Glencoe are very poorly drained neutral soils in depressions and low gradient drainageways. Minor soils included are Canisteo soils adjacent to or intermingled with Webster soils and Crippin soils adjacent to or intermingled with Nicollet soils.

Cropland is the principal land use. Corn and soybeans are the major crops. Wetness on the poorly and very poorly drained soils is the principal limitation to use.

4. **Rolling Broad Summit Ground Moraine**

This area consists of gently undulating hilltops bounded by smooth side slopes with convex shoulders and concave foot slopes. The hills rise 10 to 50 feet above a broad, low gradient lower level. An associated minor landform lacks the broad summits. A few areas have irregular relief. Slopes on the upper level are short, 60 to 100 feet in length, and are dominantly 2 to 3 percent. Side slopes are commonly smooth, 80 to 150 feet in length, and range from 4 to 18 percent. Drainage is poorly integrated.

a. **Aastad-Forman-Parnell Association:**

Aastad are moderately well to somewhat poorly drained, neutral to mildly alkaline, nearly level soils on toe slopes or on flats and swales. Forman are well drained, neutral to mildly alkaline, gently sloping to moderately steep soils on smooth side slopes and knolls. Parnell are very poorly drained, neutral soils in depressions and swales. Minor soils included are Buse and Langhei soils on convex slopes, Flom and Vallers soils adjacent to Parnell and Quam soils that are in depressions, and Hamerly soils on low convex slopes.

Cropland is the principal use. The hazard of erosion on sloping soils and wetness of the very poorly drained soils are the principal limitations to use.

b. **Gonvic-Waukon-Quam Association:**

Gonvick are moderately well drained, neutral, nearly level soils in slightly convex positions. Waukon are well drained, neutral, gently sloping to rolling soils on side slopes and knolls. Quam are very poorly drained, neutral soils in depressions, in some areas.

c. **Barnes-Langhei-Svea Association:**

These are dominant soils. Barnes are well drained, neutral, gently sloping to moderately steep soils on side slopes and knolls. Langhei are somewhat excessively drained, calcareous, sloping

to moderately steep soils on convex slopes. Svea are moderately well drained, neutral, nearly level soils in slight swales and shallow drainageways. Minor soils included are Doland and Tara soils on low knolls, Flom soils on flats, Parnell soils in depressions and drainageways and Sioux soils on scattered convex knolls.

Cropland is the principal use. Corn, small grain, soybeans, sunflowers, sugarbeets, and alfalfa are the main crops. The hazard of erosion on sloping soils is the principal limitation to use. Wetness is also limiting on included poorly drained soils.

d. **Clarion-Nicollet-Webster Association:**

Clarion are well drained, neutral to slightly acide, gently sloping to moderately steep soils on knolls and side slopes. Nicollet are moderately well drained, slightly acide, nearly level soils on low knolls. Webster are poorly drained, neutral, nearly level soils on flats and narrow drainageways. Minor soils included are Storden soils on convex slopes, Terril soils on foot slopes, Canisteo soils on rims of depressions and slight rises in broad flats, and Glencoe, peat, and muck soils in depressions.

Cropland is the principal use. Corn, soybeans, oats, and alfalfa are the main crops. The hazard of erosion on sloping soils and wetness of poorly drained soils are the principal limitations to use.

e. **LeSueur-Lester-Cordova Association:**

LeSueur are moderately well drained, medium acid, nearly level soils on low knolls. Lester are well drained, medium acid soils located on gently sloping to moderately steep side slopes. Cordova are poorly drained, slightly acide, nearly level soils on flats. Minor soils included are Dundas soils on low convex slopes, Kilkenny soils on side slopes and knolls, and Glencoe, peat, and muck soils in depressions.

Cropland is the principal use. Native hardwood groves are common. The hazard of erosion on sloping soils and wetness of the poorly drained soils are the principal limitations to use.

5. **Gently Undulating Irregular Ground and End Moraine**

This area consists of a complex of irregular hills, knolls, and ridges with weakly defined swales and depressions. The dominant relief is 15 to 30 feet. Slopes are short, 60 to 200 feet in length, and are dominantly zero to 6 percent. Small permanent lakes are common. There are few streams.

a. **Heimdal-Sisseton-Svea Association:**

The Heimdal are well drained, neutral, gently undulating soils on side slopes and knolls. Sisseton are somewhat excessively drained, calcareous, undulating soils on steeper convex knolls and ridges. Svea are moderately well drained, neutral, nearly level soils in slight swales and drainageways. Minor soils included are Flom soils on flats and shallow swales, and Quam soils in depressions.

Cropland and pasture are the principal land uses. Corn, oats, flax, soybeans, and wheat are the main crops. The hazard of erosion on slopes is principal limitation to use. Wind erosion is also a hazard on the cultivated ridges and knolls. Stoniness is a limitation in some areas.

b. **Svea-Barnes-Quam Association:**

Svea are moderately well drained, neutral, nearly level soils in slight swales and shallow drainageways. Barnes are well drained, neutral to mildly alkaline, undulating soils on smooth side slopes and knolls. Quam are very poorly drained soils in depressions and low gradient drainageways. Minor soils included are Buse and Langhei soils on steeper convex slopes, Flom soils on flats and shallow drainageways, and Vallers on rims of depressions.

Cropland is the principal land use. Corn and soybeans are the main crops. The hazard of erosion and wetness are the principal limitations to use.

c. **Gonvick-Waukon-Quam Association:**

Gonvick are moderately well to somewhat poorly drained, slightly or medium acid, nearly level soils on low knolls. Waukon are well drained, slightly to medium acid, undulating soils on the higher knolls. Quam are very poorly drained, neutral soils in depressions. Minor soils included are Buse and Langhei soils on convex slopes and Flom on flats and in drainageways.

Cropland and pasture are the principal land uses. The hazard of erosion on sloping soils, and wetness of very poorly drained soils are the principal limitations to use.

d. **Nicollet-Webster-Clarion Association:**

Nicollet are moderately well drained, slightly acid, nearly level soils on low knolls. Webster are poorly drained, neutral, nearly level soils on flats and shallow drainageways. Clarion are well drained, neutral to slightly acid, undulating soils on side slopes and knolls. Minor soils included are Storden soils on steeper convex slopes, Canisteo soils on depression rims, and Glencoe soils in depressions and low gradient drainageways.

Cropland is the principal land use. Corn and soybeans are the main crops. The hazard of erosion on sloping soils and wetness on poorly drained soils are the principal limitations to use.

6. **Rolling Irregular Ground and End Moraine**

This area consists of a complex of irregular hills, knolls, and ridges intermingled with low gradient swales and closed depressions. The relief is 20 to 100 feet, and slope lengths range from 60 to 200 feet. Gradients range from 4 to 30 percent, but 4 to 12 percent is the most common range.

a. **Barnes-Langhei-Parnell Association:**

Barnes are well drained, neutral to mildly alkaline, undulating to rolling soils on side slopes and knolls. Langhei are somewhat excessively drained, calcareous soils on the ravine slopes. Parnell are very poorly drained, neutral to mildly alkaline soils in depressions and long, winding low gradient drainageways. Minor soils included are Buse soils on steeper convex slopes, Flom soils on flats and shallow drainageways, and Vallers soils on rims of depressions and associated with Flom soils.

Cropland and pasture are the principal land uses. Corn, oats, wheat, and alfalfa are the main crops. The hazard of erosion on sloping soils and wetness of very poorly drained soils are principal limitations to use.

b. **Lester-LeSueur-Cordova Association:**

Lester are well drained, medium acide, undulating to rolling soils on side slopes and higher knolls. LeSueur are moderately well drained, medium acid, early level soils on low convex slopes. Cordova are poorly drained, neutral to slightly acid, nearly level soils on hilltops. Minor soils included are Canisteo soils on flats, Glencoe soils in depressions and shallow drainageways, and peat and muck soils in depressions and old lake basins.

Cropland and pasture are the principal land use. A few areas are in native woodland. Corn, oats, wheat, and alfalfa are the main crops. The hazard of erosion on sloping soils, and wetness of poorly drained soils are principal limitations to use. Stoniness is a problem in some areas.

c. **Clarion-Storden-Webster Association:**

Clarion are well drained, slightly to medium acid, undulating to rolling soils on the higher knolls. Storden are well drained, calcareous, rolling soils on higher convex knolls. Webster are poorly drained, neutral or slightly acid, nearly level soils on flats and narrow drainageways. Minor soils included are Canisteo soils adjacent to or intermingled with Webster soils.

Cropland is the principal land use. Corn, soybeans, oats, and alfalfa are the main crops. The hazard of erosion on sloping land and wetness on poorly drained soils are principal limitations to use.

7. **Hilly to Steep Irregular Gound and End Moraine**

This area consists of a complex of irregular hills, knolls, and ridges with numerous deeply inset depressions and small lakes. Drainage is nonintegrated and is comprised of weakly defined swales and depressions. Peat bogs are common. The dominant relief is 20 to 100 feet or more. Slopes range from 2 to 50 percent with a dominant slope range of 8 to 25 percent. Slopes are short, 60 to 200 feet in length.

a. **Langhei-Barnes-Parnell Association:**

Langhei are somewhat excessively drained, calcareous, rolling to steep soils on the convex slopes. Barnes are well drained, neutral to mildly alkaline, rolling to steep soils on side slopes and knolls. Parnell are very poorly drained, neutral to mildly alkaline soils in depressions and long, winding, low gradient drainageways. Minor soils included are Buse soils on the ravine slopes and Flom soils on flats associated with Parnell soils.

Pasture is the principal land use with cropland on nearly level areas. The hazard of erosion and drought are the principal limitations to use. Wetness of very poorly drained soils is also limiting.

b. **Waukon-Langhei-Quam Association:**

Waukon are well drained, neutral to slightly acid, rolling to steep soils on side slopes and knolls. Langhei are somewhat excessively drained, calcareous, rolling to steep soils on the convex slopes. Quam are very poorly drained, neutral to mildly alkaline soils in depressions and low gradient drainageways. Minor soils are Buse soils on the ravine slopes and Flom soils on flats associated with Parnell soils.

Pasture is the principal land use with cropland on nearly level areas. The hazard of erosion and drought are the limitations to use. Wetness of very poorly drained soils is also limiting.

c. **Clarion-Hayden-Glencoe Association:**

Clarion and Hayden are well drained, slightly to medium acid, rolling to steep soils on side slopes and higher knolls. Glencoe are very poorly drained, neutral to mildly alkaline soils in depressions and low gradient drainageways. In Study Areas I and II, Hayden soils are replaced by calcareous Storden soils as one of the more dominant soils. Other minor soils include Canisteo and Webster in drainageways and scattered areas of Estherville on flats and knolls. In Study Area IV, the Clarion soils are replaced by Lester soils as one of the more dominant soils. Included are Nessel soils on low knolls and Dundas soils in drainageways. Peat and muck are in depressions throughout the association.

Cropland, pasture, and urban are the principal land uses, with cropland on more level areas. Hardwood groves are common. The hazard of erosion and wetness are the principal limitations to use.

8. Rolling to Steep Dead Ice Moraine

This area consists of a complex of irregular hills, knolls, and ridges with numerous deeply inset depressions and small lakes. Drainage is nonintegrated and is weakly defined by swales with deeply inset depressions. The dominant relief is 20 to 100 feet or more. Slopes range from 2 to 50 percent with a dominant slope range of 8 to 25 percent. Slopes are short, 60 to 200 feet in length.

a. Hayden-Kingsley Association:

Hayden and Kingsley are well drained, medium acid, rolling to steep soils on side slopes and knolls. Also included are Burnsville soils that are loamy over gravelly, somewhat excessively drained, slightly acid soils on side slopes and knolls. Minor soils included are Nessel soils on toe slopes, flats or swales, and Nymore soils on flats and side slopes, and peat and muck in some depressions.

Pasture, cropland, and urban are the principal uses. Large areas are idle. Corn, small grain, soybeans, and alfalfa are the main crops. The hazard of erosion on steep slopes and drought are the principal limitations to use. Wetness of minor soils also limits use.

AREAS DOMINATED BY SOILS FORMED IN SILTY MANTLED GLACIAL TILL

These are mostly upland soils formed in a silty mantled loamy glacial till. The silty mantle is thick and continuous in some areas, and thin and patchy with areas of loamy till in other areas. These are well to very poorly drained soils on a silt mantled ground moraine. Native vegetation was tall grass prairie.

9. Gently Undulating to Rolling Ground Moraine

This area consists of a complex of silt mantled low knolls that rise irregularly 5 to 20 feet above a drainage net with low gradient draws and depressions. Slopes are short, 60 to 200 feet in length and range from 2 to 12 percent, but are dominantly 2 to 6 percent. Steeper slopes adjoin lakes and streams.

a. Doland-Rothsay-Perella Association:

Doland are well drained, neutral, nearly level soils on low slightly convex slopes. Rothsay are well drained, neutral, undulating to rolling soils on convex to uniform steeper slopes. Perella are poorly drained, neutral, nearly level soils on flats and slightly concave slopes. Minor soils included are Tara soils on slight rises, Flom soils on flats, and Barnes soils on side slopes and on knolls lacking silt mantle.

Cropland is the principal land use. Small grain, corn, and soybeans are the main crops. The hazard of erosion and wetness are the principal limitations to use.

b. Kingston-Madelia-Truman Association:

Kingston are moderately well to somewhat poorly drained, neutral to slightly acid, nearly level soils on low convex rises. Madelia are poorly drained, neutral to slightly acid, nearly level soils on flats and in drainageways. Truman are well drained, slightly acid to neutral, undulating to rolling soils on side slopes and knolls. Minor soils included are Collinwood soils on low convex rises, Spicer soils on rims of depressions and broad flats, Lura and Barber soils in depressions, and Grogan soils on knolls.

Cropland is the principal land use. Corn, soybeans, and small grains are the main crops. The hazard of erosion and wetness are principal limitations to use.

c. **Doland-Aastad-Parnell Association:**

Doland are well drained, neutral, nearly level soils on low slightly convex slopes. Aastad are moderately well to somewhat poorly drained, slightly acid or neutral, nearly level soils on toe slopes or on flats and swales. Parnell are very poorly drained, neutral to mildly alkaline soils in depressions and low gradient drainageways. Minor soils include Barnes soils on side slopes and knolls, Buse and Langhei soils on the ravine slopes, Flom flats and shallow drainageways, and Svea soils in slight swales and shallow drainageways.

Cropland is the principal land use. Corn, small grain, and soybeans are the main crops. The hazard of erosion and wetness are principal limitations to use.

d. **Singsaas-Oak Lake-Flom Association:**

Singsaas are well drained, mildly alkaline, gently undulating soils on swells and side slopes. Oak Lake are moderately well drained, mildly alkaline, nearly level to gently undulating soils on low rises. Flom are poorly drained, neutral, nearly level soils on flats, concave swales, and foot slopes. The dominant minor soil is Parnell in the depressions. Also included are a few small areas of Fulda and Sinai soils.

Cropland is the major land use. Wetness on Flom soils is the principal limitation to use.

AREAS DOMINATED BY SOILS FORMED IN CLAYEY MANTLED GLACIAL TILL

These are mostly upland soils formed in a clayey mantled glacial till. The mantle is thick and continuous in some areas, and thin and patchy in other areas. Some areas with a silty mantle are also included. These are well to very poorly drained soils. Native vegetation was dominantly tall-grass prairie with some hardwood forest.

10. Nearly Level to Gently Undulating Ground Moraine

This area consists of a nearly level to gently undulating ground moraine where local relief is commonly less than 10 feet. A few higher elevations of loamy till are only partially mantled with clayey sediments. Small shallow closed depressions are numerous. The area is crossed by a few deeply entrenched streams with few side drainage channels.

a. **Marna-Guckeen-Kamrar Association:**

Marna are poorly drained, neutral, nearly level soils on flats. Guckeen are moderately well drained, slightly acid, nearly level soils on higher knolls. Minor soils included are Barbert and Lura soils in shallow swales and depressions, and Mazaska soil on flats.

Cropland is principal land use. Corn and soybeans are the main crops. Wetness is the principal limitation to use. The clayey materials also make these soils more difficult to work with.

11. Rolling and Hilly Broad Summit Ground Moraine

This area consists of 10 to 50 feet hills with nearly level to gently undulating tops bounded by smooth side slopes. They rise above a broad, low gradient lower level with depressions and lakes. A minor landform lacks the broad summits. A few areas have irregular relief. Slopes on the upper level are short, 60 to 100 feet in length, and are dominantly 2 to 3 percent. Side slopes are from 60 to 200 feet long and range from 60 to 30 percent. The steeper slopes are near lakes and streams. Drainage on the upper level is poorly integrated, and outlets into one or two weakly incised waterways to the lower level.

a. **Poinsett-Sinai-Dovray Association:**

Poinsett are well drained, neutral, sloping to moderately steep soils on side slopes and knolls. Sinai are clayey, moderately well drained, neutral, gently sloping soils on plane and convex

slopes. Dovray are very poorly drained, neutral soils in depressions and swales. Minor soils included are Barnes soils on smooth side slopes and knolls, Buse soils on steeper convex slopes, and Flom soils on flats and shallow drainageways.

Cropland is the principal land use. Small grain, corn, soybeans, and alfalfa are the major crops. Small oak groves are common. The hazard of erosion on slopes and wetness are the principal limitations to use. The clayey materials also make these soils more difficult to work with.

b. **Kilkenny-Lerdal-Mazaska Association:**

Kilkenny are well drained, acid, rolling to steep soils on side slopes and knolls. Lerdal are somewhat poorly drained acid, gently sloping soils on side slopes and knolls. Mazaska are poorly drained, neutral to acid, nearly level soils on hilltops. Minor soils included are Glencoe and Lura soils in depressions, Shields soils in shallow depressions on the level hilltops, Lester soils on side slopes and knolls, and LeSueur soils on low convex slopes.

Cropland is the principal land use. Small grain, corn, soybeans, and alfalfa are the major crops. Small oak groves are common. The hazard of erosion on slopes, and wetness are the principal limitations to use. The clayey materials also make these soils more difficult to work with.

AREAS DOMINATED BY SOILS FORMED IN LACUSTRINE MATERIALS

These are mostly soils of lake basins formed in silty and clayey lacustrine materials. They are dominantly poor to very poorly drained soils with minor amounts of moderately well drained soils. Native vegetation was tall grass, prairie, reeds, and sedges.

12. Nearly Level Lake Basin

This area consists of nearly level lake basins with remnants of sluggish stream channels. Relief on the lake plain is commonly less than 10 feet and less than five feet over wide areas. There are few lakes and peat-filled depressions, but small shallow closed depressions are numerous. The area is crossed by a few deeply entrenched streams with few side drainageways. Clayey channel areas are along low gradient stream reaches, old meander channels, and backwater areas.

a. **Colvin-Hegne-Shakopee Association:**

Colvin are poorly drained, calcareous, depressional soils. Hegne are poorly drained, calcareous, nearly level soils on flats or on crests of low microrelief. Shakopee are poorly drained, calcareous, nearly level soils underlain by sand. Minor soils included are Perella, Fulda, and Nutley.

Cropland is the principal land use. Corn, soybeans, and sugarbeets are the main crops. Wetness is the dominant limitation to use.

b. **Beauford-Guckeen-Lura Association:**

Beauford are poorly drained, neutral to slightly acid, nearly level soils on flats. Guckeen are moderately well and somewhat poorly drained, medium to slightly acid, nearly level to gently sloping soils on low convex rises. Lura are very poorly drained, neutral to slightly acid soils in depressions.

Minor soils included are Collinwood and Kamrar on slight rises, Waldorf and Marna on flats and Barbert in depressions.

Cropland is the principal land use. Corn and soybeans are the main crops. Wetness is the dominant limitation to use.

c. Collinwood-Waldorf-Lura Association:

Collinwood are moderately well to somewhat poorly drained, neutral to medium acid, nearly level soils on low convex slopes. Waldorf are poorly drained, neutral to mildly alkaline, nearly level soils on broad flats. Lura are very poorly drained, neutral to slightly acid depressional soils. Minor soils included are Guckeen and Kamrar soils on slight rises, Marna soils on flats, and Barbert soils in depressions.

Cropland is the principal land use. Corn and soybeans are the main crops. Wetness is the dominant limitation to use.

d. Beardon-Colvin Association:

Beardon are poorly drained, calcareous, nearly level soils. Colvin are poorly drained, calcareous, nearly level and depressional soils. Minor soils included are Hamerly, Hantho, McIntosh, and Perella soils.

Cropland is the principal land use. Corn, soybeans, and sugarbeets are the main crops. Wetness is the main limitation to use. Soil blowing and soil compaction are problems in cropland management. Special fertility management is needed on calcareous soils.

e. Rauville-Dovray-Lamoure Association:

Rauville are very poorly drained, calcareous soils in old meander channels, backwater areas, and high-water table bottomland. Dovray are very poorly drained, neutral soils in depressions and slack water areas. Lamoure are poorly drained, calcareous, nearly level, soils on flood plains. Minor soils included are LaPrairie and alluvial lands.

Cropland and pasture are the principal land uses. Wetness and the hazard of flooding are the main limitations to use.

AREAS DOMINATED BY SOILS FORMED IN OUTWASH AND STREAM ALLUVIUM

The soils formed in outwash consist of loamy material over sands and gravel on sands, and gravelly sands. In areas of collapsed alluvium, some soils are loamy throughout. Most soils on the flood plains are also loamy throughout. These soils range from excessively to very poorly drained. Native vegetation was dominantly tall grass prairie.

13. Nearly Level to Gently Sloping Outwash and Valley Trains, Kames, and Stream Terraces

This area consists of mostly broad, nearly level to gently undulating outwash plains, deltas, stream terraces, and stream alluvium. Soils on narrow flood plains have been included as minor soils in the following associations.

a. Fordville-Renshaw-Sioux Association:

Fordville are well drained, neutral, nearly level soils underlain by sand and gravel at 24 to 36 inches. Renshaw are somewhat excessively drained, neutral, nearly level to sloping soils underlain by sand and gravel at less than 24 inches. Sioux are excessively drained, mildly alkaline, sloping to steep soils onterrace escarpments, knolls, and ridge tops. Minor soils included are the Divide and Spottswood soils.

Cropland and pasture are the principal land use. Small grain and corn are the main crops. Drought and hazard of wind erosion are principal limitations to use.

b. Shible-Grogan-Sparta Association:

Shible are well drained, neutral, nearly level soils underlain by sand at 24 to 40 inches. Grogan are well drained, neutral, gently sloping soils underlain by strata of very fine sand and

silts. Sparta are excessively drained, medium acid, gently sloping sandy soils. Minor soils included are Torning, Maddock Swenoda, Clontarf, Arveson, Fieldon, and Darfur soils. Shible and associated minor soils are dominant in Study Area 3 whereas Grogan and associated soils are dominant in Study Area 1.

Cropland and pasture are the principal land uses. Corn, soybeans, small grain, and alfalfa are the main crops. Drought and hazard of wind erosion are dominant limitations to use.

c. **Marysland-Litchfield-Forada Association:**

Marysland are poorly drained, calcareous, nearly level soils underlain by sand and gravel at 24 to 40 inches. Litchfield are moderately well to somewhat poorly drained, slightly acid to neutral, nearly level soils on slightly convex rises. Forada are poorly and very poorly drained, neutral, nearly level soils underlain by sand and gravel from 22 to 40 inches. Minor soils included are Estherville, Salida, and Wadena soils on more sloping areas.

Cropland is the principal land use. Corn, soybeans, small grains, and alfalfa are the major crops. Drought, wetness, and wind erosion are principal limitations to use.

d. **Estherville-Fairhaven-Bascay Association:**

Estherville are somewhat excessively drained, slightly acid, gently sloping soils underlain by sand and gravel at 12 to 24 inches. Fairhaven are well drained, slightly acid, nearly level soils underlain by sand and gravel at 24 to 36 inches. Biscay are poorly drained, neutral, nearly level soils underlain by sand and gravel at 24 to 36 inches. Minor soils included are Salida and Wadena soils on more sloping areas.

Cropland is the principal land use. Corn, soybeans, small grains, and alfalfa are the major crops. Drought, wetness, and wind erosion are principal limitations to use.

e. **Dorset-Clontarf-Forada Association:**

Dorset are well drained, slightly acid to neutral soils on broad outwash flats and convex slopes. Clontarf are moderately well drained, slightly acid or neutral, nearly level soils on broad flats. Forada are poorly and very poorly drained, neutral to mildly alkaline, nearly level soils with sand and gravel below 24 to 36 inches. Minor soils included are Sioux, Arvilla, and Osakis.

Cropland is the principal land use. Corn, soybeans, small grains, and alfalfa are the major crops. Drought, wetness, and wind erosion are the principal limitations to use.

f. **Litchfield-Biscay-Canisteo Association:**

Litchfield are moderately well to somewhat poorly drained, slightly acid to neutral, nearly level soils on slight rises. Biscay are poorly drained, neutral, nearly level soils on flats underlain by sand and gravel at 26 to 40 inches. Canisteo are poorly drained, calcareous, nearly level soils. Minor soils included are Dassel, Grogan, Mayer, and Nicollet soils.

Cropland is the principal land use. Corn, small grain, soybeans, and alfalfa are the principal crops. Wetness is the dominant limitation to use.

14. **Rolling to Steep Collapsed Alluvium, Stream Alluvium, or Pitted Outwash**

This area consists of a complex of oriented ridges, conical hills, and irregular knolls rising 15 to 100 feet above the adjacent swales and depressions. Drainage is non-integrated. Deeply inset depressions are common. In many places, soils occur as associated loamy or sandy soils, or are so intimately mixed with loamy drift that they are mapped as complexes.

a. **Langhei-Waukon-Salida Association:**

Landhei are somewhat excessively drained, calcareous, sloping to steep soils on convex slopes. Waukon are well drained, neutral to slightly acid, sloping soils on side slopes and knolls. Salida are excessively drained, calcareous, sloping to steep soils on convex knolls and side slopes. Minor soils included are Biscay and Mayer soils in depressions and on depression rims; and peat, muck, and Quam soils in depressions.

Pasture is principal land use with cropland on the more level areas. The hazard of erosion and drought are principal limitations to use. Wetness of included soils is also limiting.

b. **Marquette-Dorset-Nymore Association:**

Marquette are excessively drained slightly to medium, acid, steep soils. Dorset are somewhat excessively drained, neutral to slightly acid, level to steep soils on slopes. Nymore are excessively drained medium to strongly, acid, level to steep soils. Minor soils included are Biscay and Mayer soils in depressions and on depression rims; peat, muck, and Quam soils in depressions.

Pasture is principal land use with cropland on the more level areas. The hazard of erosion and drought are principal limitations to use. Wetness of included soils is also limiting.

15. **Nearly Level Flood Plains**

This area consists of a broad alluvial plain with a few gentle rises, meander channels, and rock benches in the Minnesota River Valley.

a. **Chaska-Dorchester-Oshawa-Rocky Benches Association:**

Chaska are poorly drained, calcareous, nearly level soils. Dorchester are moderately well drained, calcareous, nearly level soils on slightly convex slopes. Oshawa are very poorly drained, calcareous soils in old meander channels and backwater areas. Rocky benches are level to rolling rock outcrops. Minor soils included are Marysland and alluvial land.

Principal land uses are for pasture, idle land, and cropland, with corn and soybeans the main crops. The hazard of flooding and wetness are dominant limitations to use.

U S DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

LEGEND

GENERAL SOIL MAP AND GEOMORPHIC SURFACES

AREAS DOMINATED BY SOILS FORMED IN LOAMY MATERIAL

Coteau Slope - Gently Sloping Till Plain with Steep Scarps
- 1a. Aastad-Forman-Parnell Association
- 1b. Nicollet-Clarion-Webster Association

Gently Sloping Ground Moraine
- 2a. Nicollet-Storden Canisteo Association
- 2b. Svea-Hammerly-Vallers Association

Nearly Level Ground Moraine
- 3a. Peever-Tonka Association
- 3b. Hammerly-Oldham-Parnell Association
- 3c. Hammerly-Winger-Parnell Association
- 3d. Webster-Nicollet-Glencoe Association

Rolling, Broad Summit Ground Moraine
- 4a. Aastad-Forman-Parnell Association
- 4b. Gonvick-Waukon-Quam Association
- 4c. Clarion-Nicollet-Webster Association
- 4d. LeSueur-Lester-Cordova Association

Gently Undulating Irregular Ground and End Moraine
- 5a. Heimdal-Sisseton-Svea Association
- 5b. Svea-Barnes-Quam Association
- 5c. Gonvick-Waukon-Quam Association
- 5d. Nicollet-Webster-Clarion Association

Rolling Irregular Ground and End Moraine
- 6a. Barnes-Langhei-Parnell Association
- 6b. Lester-LeSueur-Cordova Association
- 6c. Clarion-Storden-Webster Association

Hilly to Steep Irregular Ground and End Moraine
- 7a. Langhei-Barnes-Parnell Association
- 7b. Waukon-Langhei-Quam Association
- 7c. Clarion-Hayden-Glencoe Association

Rolling to Steep Dead Ice Moraine
- 8a. Hayden-Kingsley-Chetek Association

AREAS DOMINATED BY SOILS FORMED IN SILTY MANTLED GLACIAL TILL

Gently Undulating to Rolling Ground Moraine
- 9a. Doland-Rothsay-Perella Association
- 9b. Kingston-Madelia-Truman Association
- 9c. Doland-Aastad-Parnell Association
- 9d. Singsass-Oak Lake-Flom Association

AREAS DOMINATED BY SOILS FORMED IN CLAYEY MANTLED GLACIAL TILL

Nearly Level to Gently Undulating Ground Moraine
- 10a. Marna-Guckeen-Kamrar Association

Rolling and Hilly Broad Summit Ground Moraine
- 11a. Poinsett-Sinai-Dovray Association
- 11b. Kilkenny-Lerdal-Mazaska Association

AREAS DOMINATED BY SOILS FORMED IN LACUSTRINE MATERIALS

Nearly Level Lake Basin
- 12a. Colvin-Hegne-Shakopee Association
- 12b. Beauford-Guckeen-Lura Association
- 12c. Collinwood-Waldorf-Lura Association
- 12d. Bearden-Colvin Association
- 12e. Rauville-Dovray-Lamoure Association

AREAS DOMINATED BY SOILS FORMED IN OUTWASH AND STREAM ALLUVIUM

Nearly Level to Gently Sloping Outwash and Valley Trains, Kames and Stream Terraces
- 13a. Fordville-Renshaw-Sioux Association
- 13b. Shible-Grogan-Sparta Association
- 13c. Marysland-Litchfield-Forada Association
- 13d. Estherville-Fairhaven-Biscay Association
- 13e. Dorset-Clontarf-Forada Association
- 13f. Litchfield-Biscay-Canisteo Association

Rolling to Steep Collapsed Alluvium, Stream Alluvium or Pitted Outwash
- 14a. Langhei-Waukon-Salida Association
- 14b. Marquette-Dorset-Nymore Association

Nearly Level Flood Plains
- 15a. Chaska-Dorchester-Oshawa-Rocky Benches Association

Ad hoc Symbols
- Steep valley slopes

SOURCE:
SCS DRAWING NUMBER 5,S-29,422 AND INFORMATION FROM FIELD TECHNICIANS.

USDA-SCS-LINCOLN NEBR 1972

BASE LEGEND
- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE

GENERAL SOIL MAP AND GEOMORPHIC SURFACES

MINNESOTA RIVER BASIN

MINNESOTA, SOUTH DAKOTA, AND IOWA

SHEET 1 OF 4

8-21-72

5,P-30,671.1

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SCALE 1/500,000

SCALE 10 0 10 20 30 MILES

TRANSVERSE MERCATOR PROJECTION

LEGEND
GENERAL SOIL MAP AND GEOMORPHIC SURFACES

AREAS DOMINATED BY SOILS FORMED IN LOAMY MATERIAL

Coteau Slope - Gently Sloping Till Plain with Steep Scarps
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Gently Sloping Ground Moraine
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Rolling, Broad Summit Ground Moraine
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Gently Undulating Irregular Ground and End Moraine
- 5a. Heimdal-Sisseton-Svea Association
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Rolling to Steep Dead Ice Moraine
- 8a. Hayden-Kingsley-Chetek Association

AREAS DOMINATED BY SOILS FORMED IN SILTY MANTLED GLACIAL TILL

Gently Undulating to Rolling Ground Moraine
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- 12a. Colvin-Hegne-Shakopee Association
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- 15a. Chaska-Dorchester-Oshawa-Rocky Benches Association

Ad hoc Symbols
- Steep valley slopes
- Sioux Quartzite

BASE LEGEND
- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE

MINNESOTA

SOURCE:
SCS DRAWING NUMBER 5,S-29,422 AND INFORMATION FROM FIELD TECHNICIANS.

USDA SCS-LINCOLN NEBR 1973

GENERAL SOIL MAP AND GEOMORPHIC SURFACES
MINNESOTA RIVER BASIN
MINNESOTA, SOUTH DAKOTA, AND IOWA
SHEET 2 OF 4

8-21-72
5,P-30,671.2

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

LEGEND

GENERAL SOIL MAP AND GEOMORPHIC SURFACES

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- 15a. Chaska-Dorchester-Oshawa-Rocky Benches Association

Ad hoc Symbols

Steep valley slopes

SOURCE:
SCS DRAWING NUMBER 5,S-29,422 AND INFORMATION FROM FIELD TECHNICIANS.

USDA-SCS-LINCOLN NEBR 1972

JOINS INSET

INSET

SCALE 1/500,000

SCALE 10 0 10 20 30 MILES

TRANSVERSE MERCATOR PROJECTION

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE

MINNESOTA

GENERAL SOIL MAP AND GEOMORPHIC SURFACES

MINNESOTA RIVER BASIN

MINNESOTA, SOUTH DAKOTA, AND IOWA

SHEET 3 OF 4

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5,P-30,671.3

U S DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

LEGEND

GENERAL SOIL MAP AND GEOMORPHIC SURFACES

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Ad hoc Symbols

Steep valley slopes

SOURCE:
SCS DRAWING NUMBER 5,S-29,422 AND INFORMATION FROM FIELD TECHNICIANS.

USDA-SCS-LINCOLN, NEBR. 1972

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE

MINNESOTA

N

KANDIYOHI
CHIPPEWA
RENVILLE
MC LEOD
SIBLEY
NICOLLET
LE SUEUR
RICE
CARVER
SCOTT
HENNEPIN
DAKOTA

HAWK CR.
CHETOMBA CR.
HIGH ISLAND CREEK
RUSH RIVER
MIDDLE BR. SOUTH BR.
RIVER
SAND CR.
MINNESOTA RIVER
MIDDLE LAKE
SWAN LAKE
MINNESOTA

45°
95°
94°
44°30'

SCALE 1/500,000

SCALE 10 0 10 20 30 MILES

TRANSVERSE MERCATOR PROJECTION

GENERAL SOIL MAP AND GEOMORPHIC SURFACES

MINNESOTA RIVER BASIN

MINNESOTA, SOUTH DAKOTA, AND IOWA

SHEET 4 OF 4

8-21-72

5,P-30,671.4

APPENDIX B

UPSTREAM RESERVOIR SITE INVENTORY

INTRODUCTION

This is an inventory of water storage opportunities in upstream watersheds in the Minnesota River Basin. The information presented was gathered and developed by the Soil Conservation Service. The report contains preliminary data on 308 tentative reservoir sites with additional data on 187 of these sites which have floodwater storage capacity.

The purpose of this section is to summarize the potential of upstream structures in the Minnesota basin for floodwater storage and other beneficial uses. More intensive investigations should be made to substantiate topographic and geologic data before sites are selected for detailed planning and development. The inventory reflects only the physical potential for storage in the basin, and economic justification of sites is not implied.

STUDY PROCEDURE

1. Site Selection

Three hundred and eight tentative reservoir sites were selected for evaluation by a study of U.S. Geological Survey (USGS) topographic maps and from suggestions made by interested persons. In general, sites were limited to drainage areas of 100 square miles or less. A few sites were included with drainage areas exceeding this limit where storage potential appeared to be good or interest was indicated in a specific site.

Significant effects on railroads, interstate highways, main state highways, towns, and concentrations of buildings were avoided in selecting sites. Individual farmsteads and other roads were not considered to be prohibitive factors.

Sites are numbered according to the SCS Conservation Needs Inventory watershed unit designations. For example, Blue Earth River tributaries begin with 8e. The Watonwan River area is 8e1, and the LeSueur River is 8e2. Locations of sites evaluated by study area are shown on the accompanying site inventory maps.

2. Structure Study and Evaluation

Areas inundated and available storage for each site were determined from USGS maps. A representative group of sites were investigated in detail to establish reservoir storage requirements for floodwater detention. The tentative sites were then screened, and those having storage adequate for floodwater detention were selected for further analysis.

Preliminary designs were made for 187 sites showing floodwater storage potential. Structure data appear in Table B-1. Since some of these are alternates on the same stream, use of certain sites would eliminate development of others. Reservoir storage includes sediment, temporary floodwater, and other beneficial uses. Sediment volume was estimated for a 100 year period. Temporary floodwater storage is normally from two to four inches of runoff from the watershed.

All structures were assumed to have unregulated fixed spillways designed for at least moderate hazard conditions. Spillway discharges were kept low for the first inch of floodwater storage, and the maximum discharges were varied as required by available storage. A minimum vertical distance of two feet was assumed between the permanent pool and emergency spillway elevations.

A field reconnaissance was made of about 40 percent of the sites shown on Table B-1. A surface investigation of 60 larger sites was made by a geologist to determine if there were any apparent geologic conditions that would affect the water holding capability or cause foundation problems.

The majority of the sites reviewed have excellent to good water holding potential, whereas only about 15 percent were judged to have poor conditions for retaining permanent water storage. Foundation conditions were considered excellent on 80 percent of the sites reviewed. The remaining 20 percent of the sites would require extra foundation expenditures to overcome previous gravels, soft peat, or in some cases both conditions. The sites with poor water holding conditions also have poor foundation conditions. Practically all the sites reviewed had satisfactory earthen embankment materials available at the site for constructing the dams.

An analysis of the data given in Table B-1 was made to determine site potential for fish, wildlife, and recreation. Additional data on this analysis is contained in Chapter V of the main report.

Sites not considered adequate for flood prevention are shown in Table B-2. Although not investigated beyond a storage determination, some of these sites may be useful for other purposes. Suitability of individual sites was not determined for specific beneficial use.

COST OF RESERVOIRS

Although no reservoir costs are shown in this report, estimated construction costs are available at the Soil Conservation Service office in St. Paul, Minnesota, for those sites shown in Table B-1.

DATA LIMITATIONS

Despite the detail indicated in the reporting of surface acres, elevations, storage, and fill height, it must be emphasized that the data was obtained from computation based solely on USGS 7½ minute or 15 minute topographic maps. Field surveys were not made. It must be further emphasized that data reflects potential for development rather than actual design characteristics.

TABLE B-1. STRUCTURE DATA FOR POTENTIAL RESERVOIR SITES FOR FLOOD PREVENTION AND MULTIPURPOSE USE, STUDY AREA I – BLUE EARTH RIVER BASIN

Structure Site No.	LOCATION			Drainage Area	ELEVATION		TOTAL STOR. AVAIL.		AREA		FILL			
	County	Township	Section	Sq. Mi.	Top Dam	Em. Sp.	Ac. Ft.	Inches	Top Dam Acres	Em. Sp. Acres	Est. Max. Dam Ht. Feet	Recreation Potential	Fish Potential	Wildlife Potential
8e-03-1	Faribault	Verona	36	5.6	1,078	1,074	610	2.0	120	80	31	–	–	–
8e-03-10	Blue Earth	Judson	36	2.0	973	971	370	3.4	220	140	11	–	–	x
8e-03-13	Faribault	Winnebago City	23	1.8	1,070	1,067	1,070	11.2	160	120	42	x	x	–
8e-03-14	Faribault	Prescott	31	0.7	1,085	1,082	330	8.8	75	45	33	–	–	–
8e-11-10	Faribault	Kiester	21	7.4	1,219	1,215	1,000	2.5	210	175	15	–	–	x
8e-13-1	Freeborn	Alden	31	14.1	1,220	1,216	6,430	8.6	690	600	28	–	x	–
8e-13-10	Faribault	Blue Earth City	1	3.0	1,090	1,087	1,300	8.1	200	170	23	x	x	–
8e-14-1.1	Faribault	Verona	22	111.4	1,080	1,075	11,340	1.9	910	720	45	–	–	–
8e-14-10	Martin	Elmore	1	1.1	1,170	1,167	270	4.6	95	60	22	–	–	–
8e-15-1[1]	Martin	Fairmont	19	18.0	1,189	1,183	2,010	2.1	310	230	37	–	–	–
8e-15-10	Martin	Fraser	35	0.7	1,205	1,204	620	16.7	60	50	32	–	–	–
8e-17-3	Martin	Cedar	31	76.1	1,304	1,299	8,500	2.1	960	710	39	–	–	–
8e-17-5[2]	Martin	Rutland	5	12.3	1,134	1,130	6,520	9.9	800	650	21	x	x	–
8e-17-6[2]	Martin	Rutland	17	8.8	1,138	1,133	2,400	5.2	250	220	21	–	x	–
8e-17-10	Jackson	Enterprise	24	2.5	1,400	1,397	560	4.2	90	75	22	–	–	–
8e-17-11	Jackson	Enterprise	25	2.5	1,410	1,407	1,110	6.7	260	180	20	x	x	–
8e-17-12	Martin	Elm Creek	35	1.9	1,270	1,267	1,440	14.2	180	170	19	x	x	–
8e-17-15	Jackson	Christiania	35	2.0	1,395	1,392	1,300	12.2	190	150	33	x	x	–
8e-17-16	Jackson	Christiania	26	3.5	1,395	1,392	2,000	10.7	240	200	35	x	x	–
8e1-06-1.1	Cottonwood	Lakeside	24	22.5	1,340	1,335	8,300	6.9	500	440	48	x	x	–
8e1-06-2	Cottonwood	Mountain Lake	9,16	31.6	1,299	1,294	5,680	3.4	490	420	40	x	x	–
8e1-07-1.1	Cottonwood	Mountain Lake	34	17.7	1,330	1,326	2,320	2.5	300	230	41	–	x	–
8e1-07-3[3,2]	Watonwan	Odin	22	52.2	1,212	1,208	5,260	1.9	510	440	26	–	–	–
8e1-07-4[3,2]	Watonwan	Odin	25,26	96.0	1,205	1,199	9,420	1.8	1,150	920	26	–	–	–
8e1-07-10	Watonwan	Odin	30	1.3	1,200	1,198	920	13.2	160	140	17	–	–	x
8e1-08-2	Watonwan	South Branch	31	28.8	1,140	1,135	3,610	2.4	440	220	46	–	x	–
8e1-11-1	Watonwan	Fieldon	31	15.5	1,056	1,050	1,830	2.2	620	290	18	–	–	x
8e1-11-10	Watonwan	Rosendale	35	0.9	1,069	1,067	730	15.2	140	120	14	–	–	x
8e1-12-1[4]	Martin	Westford	6,7	23.4	1,102	1,097	4,160	3.3	700	550	28	x	x	–
8e1-13-10	Blue Earth	Ceresco	6,5	2.6	990	987	1,760	12.7	280	210	30	x	x	–
8e2-01-1	Waseca	New Richland	3	51.7	1,190	1,187	6,460	2.0	800	670	36	–	–	–

TABLE B-1. STRUCTURE DATA FOR POTENTIAL RESERVOIR SITES FOR FLOOD PREVENTION AND MULTIPURPOSE USE, STUDY AREA I – BLUE EARTH RIVER

Structure Site No.	LOCATION			Drainage Area Sq. Mi.	ELEVATION		TOTAL STOR. AVAIL.		AREA		FILL			
	County	Township	Section		Top Dam	Em. Sp.	Ac. Ft.	Inches	Top Dam Acres	Em. Sp. Acres	Est. Max. Dam Ht. Feet	Recreation Potential	Fish Potential	Wildlife Potential
8e2-01-3[2]	Blue Earth	McPherson	19	9.8	989	986	1,950	3.7	790	570	11	–	–	x
8e2-01-10	Blue Earth	Mankato	22	1.6	1,008	1,004	190	2.2	340	100	8	–	–	–
8e2-01-11	Blue Earth	McPherson	6	1.9	985	981	2,070	20.7	480	430	17	–	–	–
8e2-01-12	Blue Earth	LeRay	19	2.6	980	975	600	4.3	160	100	20	–	–	x
8e2-01-14	Blue Earth	McPherson	3,10	3.7	1,115	1,110	730	3.7	520	350	13	–	–	x
8e2-01-15	Blue Earth	McPherson	20	5.7	1,000	995	600	2.0	550	200	15	–	–	x
8e2-01-17	Steele	Berlin	8,17	1.2	1,240	1,235	620	9.8	170	90	30	x	x	–
8e-17-17	Martin	Waverly	31	1.3	1,190	1,187	410	5.9	80	60	20	–	–	x
8e-18-1	Blue Earth	Pleasant Mound	3	10.6	1,015	1,012	1,810	3.2	680	460	15	–	–	x
8e-18-2.1	Blue Earth	Pleasant Mound	1	64.9	1,020	1,014	7,040	2.0	890	620	42	–	–	–
8e-18-10	Blue Earth	Ceresco	36	4.1	1,104	999	3,240	14.8	460	350	31	x	x	–
8e-18-10.1	Blue Earth	Ceresco	36	1.9	1,000	997	1,670	16.5	340	290	17	–	–	x
8e-18-13.1	Blue Earth	Pleasant Mound	3,4	1.8	1,017	1,113	250	2.6	140	90	10	–	–	x
8e1-01-1	Cottonwood	Dale	11	11.7	1,410	1,406	2,700	4.3	560	430	19	–	–	x
8e1-01-2[3]	Cottonwood	Carson	15	31.0	1,361	1,356	5,450	3.3	430	350	41	x	x	–
8e1-01-3[3]	Cottonwood	Adrian	30,31	82.1	1,177	1,173	8,350	1.9	1,240	920	41	–	–	–
8e1-01-4	Cottonwood	Delton	36	14.0	1,300	1,296	1,800	2.4	260	150	48	–	x	–
8e1-01-5	Cottonwood	Delton	24	11.2	1,251	1,247	2,150	3.6	360	210	42	x	x	–
8e1-01-6[3]	Cottonwood	Selma	17,20	33.8	1,196	1,192	3,750	2.1	600	370	36	–	–	–
8e1-01-13	Cottonwood	Dale	5,4	3.8	1,460	1,157	1,180	5.8	400	280	15	–	–	x
8e1-01-14	Cottonwood	Dale	2,11	2.7	1,420	1,416	290	2.0	40	34	23	–	–	–
8e1-02-1	Watonwan	Butterfield	19	5.7	1,205	1,201	880	2.9	160	100	20	–	–	x
8e1-02-2	Watonwan	Butterfield	20	10.6	1,204	1,199	1,510	2.7	230	180	25	–	–	–
8e1-02-3[2]	Watonwan	Butterfield	12	7.1	1,097	1,093	1,030	2.7	410	320	10	–	–	x
8e1-03-1[2]	Watonwan	Lake	4,9	14.3	1,140	1,136	4,000	5.2	620	540	15	–	–	x
8e1-03-10	Watonwan	Butterfield	34,35	5.3	1,180	1,177	1,360	4.8	360	230	20	–	–	x
8e2-01-18	Steele	Berlin	19,30	3.2	1,230	1,225	1,420	8.3	170	140	30	x	x	–
832-04-10	Waseca	Iosco	16,17	2.7	1,090	1,085	660	4.6	110	80	27	–	–	–
8e2-04-11	Waseca	Iosco	20	2.3	1,120	1,116	1,690	13.7	380	310	18	–	–	–
8e2-04-12	Waseca	Alton	2,1	3.0	1,180	1,075	880	5.5	150	110	30	x	x	–
8e2-06-1[2]	Waseca	Wilton	19	3.9	1,063	1,059	3,400	16.3	540	490	15	x	x	–

TABLE B-1. STRUCTURE DATA FOR POTENTIAL RESERVOIR SITES FOR FLOOD PREVENTION AND MULTIPURPOSE USE, STUDY AREA I – BLUE EARTH RIVER

Structure Site No.	LOCATION			Drainage Area Sq. Mi.	ELEVATION		TOTAL STOR. AVAIL.		AREA		FILL			
	County	Township	Section		Top Dam	Em. Sp.	Ac. Ft.	Inches	Top Dam Acres	Em. Sp. Acres	Est. Max. Dam Ht. Feet	Recreation Potential	Fish Potential	Wildlife Potential
8e2-06-2[2]	Waseca	Freedom	24	21.4	1,063	1,059	4,020	3.6	930	740	15	–	–	x
8e2-06-4	Blue Earth	Medo	33	6.9	1,025	1,022	2,020	5.5	1,010	740	10	–	–	x
8e2-06-5[2]	Blue Earth	Medo	14	65.9	1,024	1,019	9,460	2.7	2,300	1,550	19	–	–	x
8e2-06-10	Blue Earth	Medo	7	4.0	1,010	1,005	1,390	6.5	360	240	20	–	–	x
8e2-06-11[2]	Blue Earth	Beauford	13,14	2.4	989	981	2,430	18.7	520	410	14	x	x	–
8e2-06-12	Blue Earth	Medo	18	0.9	1,000	995	720	15.0	100	80	22	–	–	–
8e2-06-17	Waseca	Freedom	27,34	1.4	1,060	1,055	570	7.7	180	110	18	–	–	x
8e2-07-1	Freeborn	Freeborn	7	29.1	1,174	1,169	4,070	2.6	580	410	39	–	x	–
8e2-07-3	Blue Earth	Danville	24	4.5	1,045	1,042	2,060	8.6	230	200	21	–	–	–
8e2-07-10[2]	Blue Earth	Beauford	3	2.0	1,000	995	1,300	12.2	430	290	15	–	–	x
8e2-07-11[2]	Blue Earth	Medo	31,32	2.1	1,019	1,014	1,820	16.3	350	300	16	–	–	x
8e2-07-12	Blue Earth	Danville	26,27	0.1	1,035	1,030	30	5.4	30	20	10	–	–	–
8e2-09-10	Faribault	Prescott	8,17	0.8	1,083	1,078	680	16.0	110	90	32	–	–	–
8e2-11-10	Faribault	Lake	35,36	2.5	1,089	1,085	860	6.4	130	120	18	–	–	x
STUDY AREA II														
8b-02-02	Yellow Medicine	Fortier	36	2.83	1,568	1,565	560	3.8	40	35	58	–	–	–
8b-02-04[5]	Yellow Medicine	Norman	29	180	1,460	1,454	11,600	1.2	400	315	92	x	x	–
8b-03-01[6]	Brookings, S.D.	Oak L.	12	6.13	1,810	1,807	2,221	6.8	580	445	10	–	–	x
8b-03-02[6,8]	Deuel, S.D.	Scandinav	9	72.0	1,764	1,760	8,360	3.2	380	285	19	–	–	x
8b-04-01[7]	Yellow Medicine	Norman	9	10.37	1,303	1,297	1,776	3.2	274	217	56	x	x	–
8b-04-06[7]	Yellow Medicine	Fortier	14	15.46	1,489	1,481	2,206	2.7	173	130	61	–	–	–
8b-05-02	Yellow Medicine	Fortier	9	25.2	1,590	1,585	2,700	2.0	160	120	72	–	–	–
8b-05-03[6]	Deuel	Norden	10	3.2	1,670	1,667	1,150	7.0	350	200	10	–	–	x
8b-05-04	Yellow Medicine	Norman	6	1.11	1,355	1,352.5	300	3.3	25	20	27	–	–	–
8b-05-04A[7]	Yellow Medicine	Norman	5	2.36	1,323	1,317	289	2.3	108	62	39			
8b-08-01	Deuel	Herrick	34	14.31	1,750	1,745	2,650	3.5	225	165	52	x	x	–
8b-08-02	Deuel	Norden	2	39.9	1,764	1,760	4,628	2.2	270	215	64	–	x	–
8b-08-04	Deuel	Norden	17	4.13	1,886	1,881	800	3.6	105	75	37	–	–	–

TABLE B-1. STRUCTURE DATA FOR POTENTIAL RESERVOIR SITES FOR FLOOD PREVENTION AND MULTIPURPOSE USE, STUDY AREA II – BLUE EARTH RIVER

Structure Site No.	LOCATION			Drainage Area Sq. Mi.	ELEVATION		TOTAL STOR. AVAIL.		AREA		FILL			
	County	Township	Section		Top Dam	Em. Sp.	Ac. Ft.	Inches	Top Dam Acres	Em. Sp. Acres	Est. Max. Dam Ht. Feet	Recreation Potential	Fish Potential	Wildlife Potential
8b-09-01	Yellow Medicine	Florida	4	2.69	1,331	1,327	410	2.9	100	55	35	–	–	–
8b-09-03	Yellow Medicine	Florida	3	4.95	1,300	1,296	635	2.4	80	65	35	–	–	–
8b-09-04	Lac Qui Parle	Manfred	34	1.49	1,266	1,262	250	3.0	30	25	31	–	–	–
8b-09-05[9]	Yellow Medicine	Florida	29	50.5	1,570	1,564	7,270	2.7	300	260	92	–	x	–
8b-10-02	Deuel	Glenwood	9	4.7	1,570	1,562	600	2.4	45	35	50	–	–	–
8d-02-01	Lyon	Lynd	23	2.20	1,288.5	1,284.5	390	3.3	40	30	37	–	–	–
8d-02-02	Lyon	Lake Marsh	31	7.51	1,287.5	1,282.5	1,320	3.3	120	95	45	–	x	–
8d-02-03	Lyon	Lake Marsh	29/33	6.0	1,240	1,236	880	2.8	90	70	35	–	–	–
8d-02-04	Lyon	Lake Marsh	34	2.5	1,212	1,207	410	3.0	45	40	28	–	–	–
8d-02-05	Lyon	Sodus	3	6.0	1,228.5	1,224.5	1,040	3.0	90	70	35	–	x	–
8d-02-06	Lyon	Sodus	11	5.38	1,261	1,257	860	3.0	61	55	47	–	–	–
8d-02-07	Lyon	Sodus	13	3.26	1,257	1,253	521.6	3.0	55	45	30	–	–	–
8d-02-08	Lyon	Amiret	18	3.93	1,246.5	1,242.5	628.8	3.0	55	50	38	–	–	–
8d-03-01	Brown	Milford	26	7.01	970.2	965.2	2,130	3.8	160	130	28	–	x	–
8d-03-02	Brown	Home	36	2.71	975	970	443.5	3.1	40	30	40	–	–	–
8d-03-03	Brown	Leavenworth	12	3.24	989	984	580	3.3	50	45	39	–	–	–
8d-04-05	Redwood	Sp. Dale	19	4.0	1,340	1,334	564	2.9	55	45	40	–	–	–
8d-04-06	Lyon	Monroe	2	7.0	1,285	1,280	1,035	2.6	120	65	45	–	–	–
8d-05-03	Redwood	Sp. Dale	21	4.0	1,272	1,268	420	1.8	55	45	31	–	–	–
8d-05-05	Murray	Shetek	23	6.0	1,464	1,460.5	1,600	4.6	440	370	18	–	–	x
8d-05-06	Redwood	Sp. Dale	26	7.0	1,260	1,256	1,080	3.0	120	90	52	–	–	–
8d-06-03	Cottonwood	Ann	9	6.0	1,254	1,250	850	2.9	90	70	36	–	–	–
8d-06-04	Cottonwood	Ann	6	5.0	1,260	1,257	760	3.0	70	55	32	–	–	–
8d-07-02	Cottonwood	Ann	13	11.0	1,260	1,255	1,760	3.0	190	145	34	–	x	–
8d-07-03	Cottonwood	Ann/Westbrook	36/1	48.	1,330	1,323	7,200	3.0	485	365	41	–	x	–
8d-09-01	Cottonwood	Germantown	20	20.0	1,200	1,195	2,857.5	2.7	285	250	37	–	–	–
8d-09-03	Cottonwood	Germantown	19/20	8.0	1,200	1,195	1,439.6	3.3	140	105	32	–	–	–
8d-09-04	Cottonwood	Germantown	31	2.9	1,280	1,275	548	3.6	55	42	43	–	–	–
8d-09-06	Cottonwood	Germantown	5/8	3.1	1,390	1,385	490	3.0	40	35	35	–	–	–
8d-09-07	Cottonwood	Storden	1	2.0	1,333	1,328	230	2.6	35	25	37	–	–	–

TABLE B-1. STRUCTURE DATA FOR POTENTIAL RESERVOIR SITES FOR FLOOD PREVENTION AND MULTIPURPOSE USE, STUDY AREA II – BLUE EARTH RIVER

Structure Site No.	LOCATION			Drainage Area Sq. Mi.	ELEVATION		TOTAL STOR. AVAIL.		AREA		FILL			
	County	Township	Section		Top Dam	Em. Sp.	Ac. Ft.	Inches	Top Dam Acres	Em. Sp. Acres	Est. Max. Dam Ht. Feet	Recreation Potential	Fish Potential	Wildlife Potential
8d-10-01	Brown	Stately	9	2.4	1,100	1,096	252	2.2	35	25	35	–	–	–
8d-10-02	Brown	Stately	10	1.2	1,096	1,092	250	4.0	25	18	28	–	–	–
8d-10-03	Brown	Stately	30	13.7	1,140	1,135	2,900	4.0	640	440	24	–	–	–
8d-10-04	Brown	Stately	22	3.7	1,135	1,132	760	3.8	960	740	34	–	–	–
8d-10-05	Brown	Stately	30	13.3	1,170	1,165	3,300	4.7	205	165	54	x	x	–
8d-11-01	Redwood	Charlestown	8	15.07	1,074	1,070	2,075	2.58	690	540	12	–	–	x
8-44-01	Lincoln	Alta Vista	23	3.0	1,254	1,250	397.1	2.7	45	35	28	–	–	–
8-44-03[10]	Lincoln	Alta Vista	32	61.0	1,475	1,470	9,360	2.9	410	370	72	–	x	–
8-44-04[11]	Lincoln	Alta Vista	12	18.0	1,760	1,755	1,375	2.3	145	105	44	–	–	–
8-45-02	Lincoln	Alta Vista	9	5.0	1,282	1,278	560	2.3	70	55	36	–	–	–
8-45-03[12]	Lincoln	Royal	5/4	34.0	1,653	1,647	4,700	2.6	335	250	53	–	x	–
8-45-04	Lincoln	Marble	14	7.0	1,495	1,490	1,189	3.2	120	90	57	–	–	–
8-45-05	Lincoln	Alta Vista	10	2.3	1,245	1,240	392	3.2	40	30	28	–	–	–
8-45-06	Lincoln	Alta Vista	10	2.8	1,240	1,236	580	3.5	48	36	30	–	–	–
8-46-02	Yellow Medicine	Norman	26	1.0	1,310	1,307	290	3.8	30	25	30	–	–	x
8-46-03	Yellow Medicine	Norman	25	1.0	1,285	1,280.5	163	2.6	30	25	23	–	–	x
8-46-04	Yellow Medicine	Norman	36	5.48	1,320	1,313	800	2.6	80	60	45	–	–	–
8-46-05	Lincoln	Alta Vista	6	3.52	1,300	1,295	750	3.4	80	60	42	–	–	–
8-47-02	Lincoln	Alta Vista	24	3.8	1,260	1,255	600	2.6	70	50	44	–	–	–
8-47-03	Lincoln	Alta Vista	25	2.0	1,261	1,257	366	3.8	35	25	31	–	–	–
8-47-04	Lincoln	Alta Vista	36	8.0	1,298	1,292	1,200	2.6	87	68	45	–	–	–
8-47-05	Lyon	Eidsvold	32	4.12	1,257	1,253	620	2.8	55	45	35	–	–	–
8-47-06	Lyon	Eidsvold	32	2.0	1,257	1,253	520	3.8	35	25	27	–	–	–
8-47-07	Lyon	Nordland	5/6	3.3	1,297	1,293	600	3.2	45	35	34	–	–	–
8-48-07[6]	Lincoln	Ash Lake	30	3.8	1,774	1,771	731	3.6	260	200	9	–	–	x
8-48-08	Lincoln	Limestone	26	12	1,495	1,490	1,600	2.5	140	110	47	–	x	–
8-48-09	Lincoln	Limestone	26	6.8	1,528	1,522	870	2.4	95	60	48	–	–	–
8-48-10	Lincoln	Limestone	26	4.6	1,517	1,513	687	2.8	165	95	39	–	–	–
8-49-01	Lyon	Nordland	23	5.63	1,263	1,258	730	2.6	75	55	40	–	–	–
8-59-02	Redwood	Swede's Forest	29	1,80	1,005	1,000	280	2.9	25	20	44	–	–	–
8-60-01	Redwood	Swede's Forest	35	13.29	1,027	1,024	1,900	2.8	190	140	60	–	–	–

TABLE B-1. STRUCTURE DATA FOR POTENTIAL RESERVOIR SITES FOR FLOOD PREVENTION AND MULTIPURPOSE USE
STUDY AREA II – BLUE EARTH RIVER

Structure Site No.	LOCATION			Drainage Area Sq. Mi.	ELEVATION		TOTAL STOR. AVAIL.		AREA		FILL			
	County	Township	Section		Top Dam	Em. Sp.	Ac. Ft.	Inches	Top Dam Acres	Em. Sp. Acres	Est. Max. Dam Ht. Feet	Recreation Potential	Fish Potential	Wildlife Potential
8-66-03	Pipestone	Aetna	23	2.75	1,170	1,764.5	435	2.8	45	35	30	–	–	–
8-66-04	Pipestone	Aetna	21	0.72	1,843	1,840	136	3.6	25	20	24	–	–	–
8-66-05	Pipestone	Aetna	16	1.76	1,795	1,790	296	3.1	60	40	27	–	–	–
8-66-06	Pipestone	Aetna	8	1.3	1,810	1,806	220	3.1	35	25	25	–	–	–
8-67-01	Lincoln	Hope	14/15	23.3	1,720	1,717	2,000	2.2	285	230	25	–	–	–
8-67-02	Lincoln	Hope	29	6.95	1,755	1,750	1,075	2.9	220	150	25	–	–	–
8-67-03	Lincoln	Hope	19	3.95	1,777	1,772	695	3.3	205	120	22	–	–	–
8-67-04	Lincoln	Hope	16	6.80	1,724	1,719.5	1,200	3.3	200	150	27	–	x	–
8-68-01	Lincoln	Drammen	24	1.33	1,824.5	1,819.5	260	3.6	45	30	23	–	–	–
8-69-01[13]	Lyon	Coon Creek	16/17	85.0	1,622	1,617.5	1,460	3.3	1,360	1,200	27	–	–	x
8-70-01	Lyon	Nordland	24	1.6	1,259	1,254	240	2.8	40	25	22	–	–	–
8-70-02	Lyon	Nordland	25	1.07	1,268	1,263.5	160	2.8	30	25	31	–	–	–
8-70-03	Lyon	Grandview	30	4.15	1,226	1,220.5	695	3.0	105	65	30	–	–	–
8-70-04	Lyon	Island Lake	1	3.11	1,325	1,320.5	640	3.8	45	35	39	–	–	–
8-70-05	Lyon	Island Lake	23	27.13	1,443	1,437.5	6,700	4.5	385	315	61	x	x	–
8-70-07	Lyon	Lynd	10	9.25	1,258	1,252	1,360	3.0	360	170	34	–	x	–
8-80-02	Redwood	Sherman	22	19.16	1,005	1,000	2,790	2.7	310	110	60		x	–
8-87-01	Brown	Home	27	11.7	910	906	1,700	2.3	45	40	83	–	–	–
8-97-03	Brown	Bashaw	29	5.12	1,119	1,115	1,100	2.4	145	85	34	–	–	–
						AREA III								
08-05-01	Traverse	Folsom	34	2.2	1,090	1,085	1,090	9.3	45	40	77	–	–	–
08-11-01	Big Stone	Foster	35	24.3	1,055	1,050	3,870	3.0	165	130	78	–	x	–
08-14-01	Big Stone	Lockwood	12	17.6	1,060	1,055	1,660	1.8	170	125	46	–	–	–
08a-01-01	Grant	Erdahl	8	11.0	1,190	1,185	3,700	6.3	540	490	19	x	x	–
08a-01-03	Stevens	Rendsville	35	0.3	1,150	1,145	45	2.7	12	8	18	–	–	–
08a-01-04	Stevens	Hodges	17	6.9	1,130	1,125	2,720	7.4	420	290	40	x	x	–
08a-01-05	Stevens	Hodges	18	6.0	1,130	1,125	930	2.9	250	125	40	x	x	–
08a-02-01	Grant	Pelican Lake	18	136.6	1,220	1,215	34,000	4.7	9,990	8,800	28	–	x	–

TABLE B-1. STRUCTURE DATA FOR POTENTIAL RESERVOIR SITES FOR FLOOD PREVENTION AND MULTIPURPOSE USE STUDY AREA III – BLUE EARTH RIVER

Structure Site No.	LOCATION			Drainage Area	ELEVATION		TOTAL STOR. AVAIL.		AREA		FILL			
	County	Township	Section	Sq. Mi.	Top Dam	Em. Sp.	Ac. Ft.	Inches	Top Dam Acres	Em. Sp. Acres	Est. Max. Dam Ht. Feet	Recreation Potential	Fish Potential	Wildlife Potential
08a-05-01	Stevens	Darnen	24	0.7	1,120	1,115	340	8.8	70	40	30	–	–	–
08a-05-05	Swift	Fairfield	8	0.9	1,100	1,095	115	2.4	40	20	30	–	–	–
08a-06-01	Stevens	Synnes	36	2.3	1,080	1,075	870	7.2	175	120	24	x	x	–
08c-02-01	Stevens	Swan Lake	14	0.2	1,210	1,205	65	5.3	12	9	10	–	–	–
08c-07-03[14]	Swift	Kerkhoven	4	88.4	1,100	1,095	25,430	5.4	3,010	2,570	27	x	x	–
08c-08-01	Swift	Kerkhoven	16	8.4	1,190	1,185	2,280	5.1	210	170	43	x	x	–
08c-09-02	Swift	Kerkhoven	31	2.2	1,100	1,095	690	5.8	75	60	35	–	x	–
08c-10-01[15]	Swift	Hayes	36	1.6	1,160	1,155	700	8.2	110	100	14	–	–	x
08-112-01	Nicollet	Lake Prairie	9	32.1	830	825	3,910	2.3	140	130	77	–	–	–
08-129-01	Scott	Cedar Lake	15	19.9	960	955	6,160	5.8	720	600	24	x	x	–

STUDY AREA I

[1]Structure 8e-15-1 is primarily for sediment detention.
[2]Existing lake utilized for sediment requirements.
[3]Design assumes upstream structures in series.
[4]Structure 8e1-12-1 assumes Mink Creek diverted into Perch Creek.

STUDY AREA II

[5]Location is approximately the same as Corps of Engineers Site No. 14 from Corps of Engineers Yellow Medicine and Lac Qui Parle.
[6]In conjunction with existing lake.
[7]Canby Creek Watershed Project site.
[8]Location is approximately the same as Corps of Engineers Site No. 10 from Corps of Engineers Yellow Medicine and Lac Qui Parle.
[9]Location is approximately the same as Corps of Engineers Site No. 38 from Corps of Engineers Yellow Medicine and Lac Qui Parle.
[10]Location is approximately the same as Corps of Engineers Site No. 21 from Corps of Engineers Yellow Medicine and Lac Qui Parle.
[11]Lake Shaokaton is utilized for sediment control.
[12]Location is approximately the same as Corps of Engineers Site No. 16 from the Corps of Engineers Yellow Medicine and Lac Qui Parle.
[13]Lake Benton and Dead Coon Lake are utilized for sediment control.

STUDY AREA III

[14]In conjunction with two existing lakes.
[15]In conjunction with existing lake.

TABLE B-2. OTHER SITES EVALUATED, STUDY AREA I – BLUE EARTH RIVER BASIN

Site No.	Drainage Area (Sq. Mi.)	Storage Available (Ac. Ft.)	(Inches)
8e-03-11	0.7	30	0.9
8e-03-12	1.6	40	0.5
8e-09-1	86.4	1,900	0.4
8e-10-1	30.8	1,100	0.7
8e-10-2	78.4	2,700	0.7
8e-16-1	45.2	2,410	1.0
8e-16-10	5.0	60	0.2
8e-17-1	46.0	2,190	0.9
8e-17-2	28.6	1,060	0.7
8e-17-4	190.0	9,930	1.0
8e-17-13	3.2	50	0.3
8e-17-14	2.0	180	1.7
8e-18-3	83.5	6,400	1.4
8e-18-11	1.8	92	0.1
8e-18-12	0.1	0	0
8e-18-13	1.7	70	0.8
8e1-01-7	17.2	1,700	1.8
8e1-01-10	2.9	290	1.9
8e1-01-11	1.6	170	1.8
8e1-01-12	2.7	200	1.5
8e1-01-15	1.7	140	1.5
8e1-02-4	25.5	1,950	1.4
8e1-02-5	32.2	3,000	1.7
8e1-05-10	5.3	420	1.5
8e1-07-1	16.3	270	0.3
8e1-07-2	35.0	980	0.5
8e1-07-5	115.1	7,910	1.3
8e1-08-1	19.6	1,730	1.7
8e1-13-1	19.8	1,480	1.4
8e2-01-2	10.2	440	0.8
8e2-01-13	1.5	10	0.1
8e2-01-16	3.7	350	1.8
8e2-06-3	41.8	3,600	1.6
8e2-06-6	129.4	3,030	0.4
8e2-06-13	3.0	50	0.3
8e2-06-14	2.8	40	0.3
8e2-06-15	2.4	60	0.5
8e2-06-16	1.6	60	0.7
8e2-07-2	79.1	2,420	0.6
8e2-07-4	128.3	4,330	0.6
832-07-13	0.4	30	1.5
8e2-09-11	3.0	130	0.8
8e2-11-1	50.0	1,930	0.7
STUDY AREA II – UPPER MINNESOTA RIVER SUBBASIN			
8b-02-01	71.6	1,960	0.5
8b-05-01	31.2	700	0.4
8b-08-03	21.4	1,320	1.2
8b-09-02	1.4	110	1.6
8b-10-01	43.0	3,570	1.6
8b-11-01	36.9	3,540	1.8
8d-01-01	47.7	5,750	2.2
8d-01-02	27.0	1,780	1.2
8d-04-01	14.0	570	0.8
8d-04-02	15.6	1,650	2.0

TABLE B-2. OTHER SITES EVALUATED, STUDY AREA II – UPPER MINNESOTA RIVER SUBBASIN

Site No.	Drainage Area (Sq. Mi.)	Storage Available (Ac. Ft.)	(Inches)
8d-04-03	24.2	1,470	1.1
8d-04-04	3.9	220	1.1
8d-05-01	91.0	5,000	1.0
8d-05-02	61.1	7,230	2.2
8d-05-04	53.4	4,930	1.7
8d-06-01	53.5	2,820	1.0
8d-06-02	16.7	410	0.5
8d-07-01	12.7	1,420	0.5
8d-07-04	46.0	4,620	1.9
8d-08-01	205.0	6,790	0.6
8d-08-02	32.0	2,480	1.5
8d-09-02	11.6	1,080	1.8
8d-09-05	1.5	150	1.9
8-44-02	60.0	1,670	0.8
8-45-01	50.2	1,210	0.5
8-46-01	1.56	80	0.9
8-47-01	23.7	640	0.5
8-48-01	97.4	410	0.1
8-48-02	14.5	880	1.1
8-48-03	80.9	2,200	0.5
8-48-04	15.4	1,120	1.4
8-48-05	74.5	550	0.1
8-48-06	67.8	5,000	1.4
8-59-01	29.4	1,990	1.3
8-62-01	28.9	3,650	1.8
8-66-01	139.0	1,170	0.2
8-66-02	125.0	4,430	0.7
8-67-04.1	6.0	90	0.3
8-70-06	35.8	100	0.1
8-71-01	85.7	260	0.1
8-77-01	39.0	2,080	1.0
8-80-01	64.0	7,510	2.2
8-83-01	20.9	1,280	1.1
8-86-01	32.9	1,840	1.1
8-91-01	10.9	190	0.3
8-97-01	8.9	590	1.2
8-97-02	2.8	170	1.2
8-97-04	235.0	1,430	1.2
8-97-05	16.0	1,330	1.6
8-102-01	70.4	1,820	0.4
STUDY AREA III – MINNESOTA RIVER HEADWATER SUBBASIN			
08-09-01 Big Stone Co.	62.2	250	0.8
08-13-01 Big Stone Co.	6.1	155	0.5
08-16-01 Grant Co., S.D.	17.5	250	0.3
08-16-02 Roberts Co., S.D.	12.2	475	0.7
08a-01-02 Stevens Co.	0.6	25	0.8
08a-04-01 Stevens Co.	6.0	425	1.3
08a-04-02 Stevens Co.	141.4	14,020	1.9
08a-05-02 Stevens Co.	5.1	355	1.3
08a-05-03 Stevens Co.	4.6	220	0.9
08a-05-04 Stevens Co.	2.4	225	1.8
08a-07-01 Swift Co.	15.1	1,150	1.4
08c-01-01 Grant Co.	186.0	8,620	0.9
08c-06-01 Swift Co.	50.5	5	0.0
08c-07-01 Pope Co.	11.1	530	0.9
08c-07-02 Pope Co.	8.1	910	2.1
08c-14-01 Kandiyohi	52.7	1,040	0.4

TABLE B-2. OTHER SITES EVALUATED, STUDY AREA IV – LOWER MINNESOTA RIVER SUBBASIN

Site No.	Drainage Area (Sq. Mi.)	Storage Available (Ac. Ft.)	(Inches)
08-58-01 Renville Co.	10.5	495	0.9
08-58-02 Renville Co.	14.9	970	1.2
08-61-01 Renville Co.	45.4	2,690	1.1
08-73-01 Renville Co.	9.1	240	0.5
08-89-01 Nicollet Co.	53.4	3,800	1.4
08-90-01 Nicollet Co.	29.6	2,300	1.4
08-100-01 Nicollet Co.	75.8	5,400	1.6
08-106-01 Nicollet Co.	35.9	2,920	1.5
08-119-01 Sibley Co.	353.5	18,250	1.0
08-121-01 Sibley Co.	208.6	12,490	1.1
08-121-03 Sibley Co.	234.3	19,590	1.6
08-139-01 Hennepin	12.0	215	0.3

U. S. DEPARTMENT OF AGRICULTURE

MINNESOTA

N

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- SUBBASIN BOUNDARY

LEGEND

- SITES INVESTIGATED
- SITES INVESTIGATED THAT HAVE STORAGE POTENTIAL FOR FLOOD PREVENTION
- SITES WITH FISH OR WILDLIFE POTENTIAL
- SITES WITH RECREATION AND FISH POTENTIAL

SCALE 1/500,000

SCALE 5 0 5 10 15 MILES

SOURCE:
FAMILY OF MAPS SCS DRAWING NO. 5, S-29,830
AND INFORMATION FROM FIELD TECHNICIANS.
TRANSVERSE MERCATOR PROJECTION.

USDA SCS-LINCOLN NEBR 1975

RESERVOIR SITE INVENTORY
STUDY AREA 1

BLUE EARTH RIVER

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

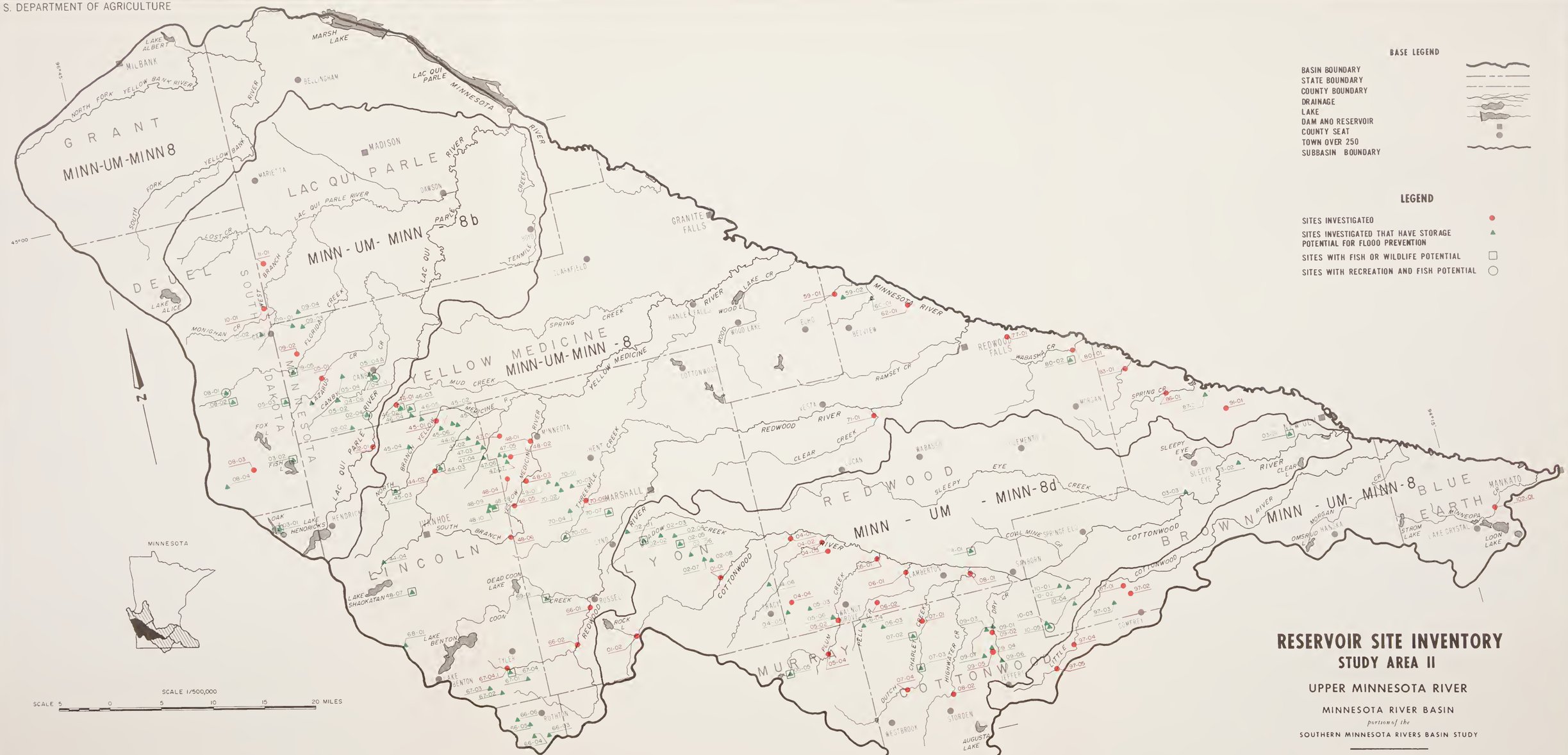
MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 1

7/22/75

5,S-35,331

U. S. DEPARTMENT OF AGRICULTURE



BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- DAM AND RESERVOIR
- COUNTY SEAT
- TOWN OVER 250
- SUBBASIN BOUNDARY

LEGEND

- SITES INVESTIGATED
- SITES INVESTIGATED THAT HAVE STORAGE POTENTIAL FOR FLOOD PREVENTION
- SITES WITH FISH OR WILDLIFE POTENTIAL
- SITES WITH RECREATION AND FISH POTENTIAL

RESERVOIR SITE INVENTORY
STUDY AREA II

UPPER MINNESOTA RIVER

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 2

7/18/75
5,S-35,330

SOURCE:
FAMILY OF MAPS SCS DRAWING NO. 5,S-34,013
(3-29-74) AND INFORMATION FROM FIELD TECHNICIANS.
TRANSVERSE MERCATOR PROJECTION.

U. S. DEPARTMENT OF AGRICULTURE

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- SUBBASIN BOUNDARY

LEGEND

- SITES INVESTIGATED
- SITES INVESTIGATED THAT HAVE STORAGE POTENTIAL FOR FLOOD PREVENTION
- SITES WITH FISH OR WILDLIFE POTENTIAL
- SITES WITH RECREATION AND FISH POTENTIAL

RESERVOIR SITE INVENTORY

STUDY AREA III

HEADWATERS MINNESOTA RIVER

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

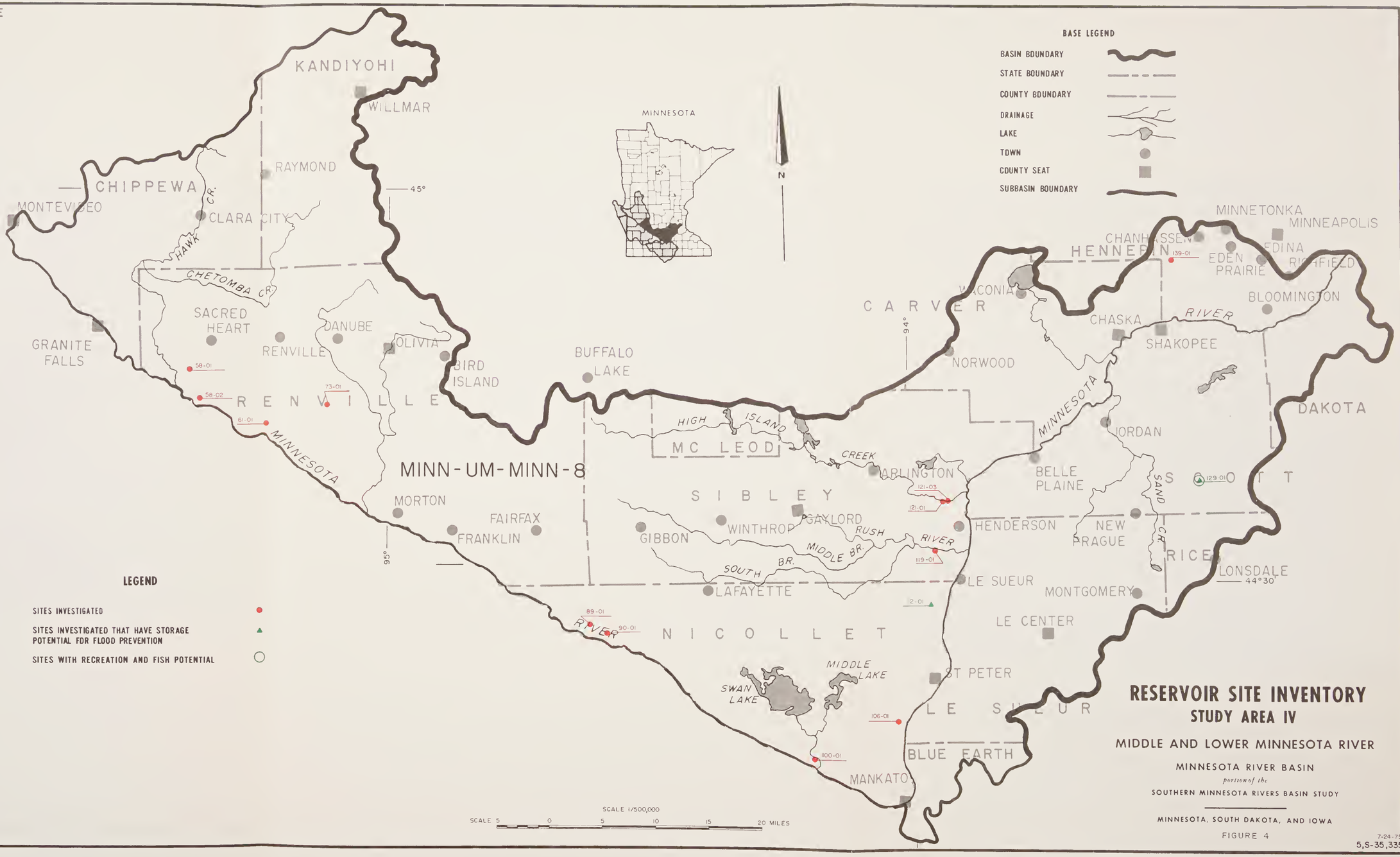
FIGURE 3

SOURCE:
FAMILY OF MAPS SCS DRAWING NO. 5,S-32,148
(3-29-74) AND INFORMATION FROM FIELD TECHNICIANS.
TRANSVERSE MERCATOR PROJECTION.

USDA-SCS-LINCOLN, NEBR. 1975

7/23/75
5,S-35,334

U. S. DEPARTMENT OF AGRICULTURE



RESERVOIR SITE INVENTORY
STUDY AREA IV

MIDDLE AND LOWER MINNESOTA RIVER

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 4

SOURCE:
FAMILY OF MAPS SCS DRAWING NO. 5,S-32,149
(7-20-73) AND INFORMATION FROM FIELD TECHNICIANS.
TRANSVERSE MERCATOR PROJECTION.

USDA SCS LINCOLN NEBR 1975

7-24-75
5,S-35,335

APPENDIX C

PRIORITY LAND USES

PRIORITY LAND USES

The increasing population and shifts of population from rural to urban areas, coupled with environmental concerns and increased demand for food production, are causing land use conflicts. Thousands of acres of land are being shifted from one use to another each year. Many of these shifts (for example – into shopping centers, homes, industrial sites, highways) are almost irreversible use of land. Much of this land is being changed from one purpose to another without regard for its value to the state and nation in producing agricultural and forest products, or for its value to wildlife and recreation purposes.

Based on soils, climate and the needs of a growing population, maps have been developed of the Minnesota Rivers Basin showing priority land uses for agriculture, green span, and woodland. In addition, maps have been prepared which indicate general land types.

Priority areas are those areas best suited for a particular use, considering other priorities. Areas listed on the maps as receiving priority should remain in that particular use because it is vital to the overall welfare of the people in the state and the nation. In areas of conflicting "land use", it will be the responsibility of decisionmakers at the local level to determine the priority use of that land. In most cases, areas of less than 10,000 acres have not been included in these maps. However, it is expected that smaller units should be included should counties decide to make similar maps. The designation of priority land uses is the first step in developing a meaningful land use plan or policy for the Minnesota River Basin.

The "General Land Types" map was, in part, a basis for delineating areas suitable for each designated use. This map contains six general land types. (These general land types are shown using a color code on the map.) These separations were based on soils information and the judgment of people familiar with the area. Each of the general land types has soils with similar characteristics that can be used extensively for the designated use. Soils information was based on the General Soil Map and Geomorphic surfaces developed for the Minnesota River Basin and on field observations. Additional information was obtained from land resource maps, which show the different soil associations, and the 1967 Minnesota Conservation Needs Inventory.

The "General Land Types" map was used as a basis by local people, familiar with the area needs and problems, to assist in preparing the priority land use maps. Persons solicited for their assistance included city and county planners, Soil Conservation Service district conservationist and local highway officials, among others. Their suggestions helped in outlining the different areas on the maps. The following definitions were used as a guideline for the use of green span, agricultural land, and woodland.

Green Span – This includes woodland, wildlife habitat, wetland and land subject to frequent flooding. Such areas provide desirable locations for recreation and wildlife use and for open green areas. These areas should be preserved for such use.

Agricultural Land – Land in farms regularly used for agricultural production. It includes all land devoted to crop or livestock enterprises.

Woodland – Any land used primarily for growing trees and shrubs. Woodland includes, in addition to what is normally forest land, those lands where shelterbelts, windbreaks, wide hedgerows containing woodland species for wildlife food or cover, and wooded streambanks.

It is hoped that these maps, developed on a study area basis as a part of the Southern Minnesota Rivers Basin Study, could be used as a valuable tool in two ways:

1. To guide the development of local land use plans at the county level.
2. To assist in a general land use plan by responsible state agencies at the state level.

These maps are working tools for decisionmakers and other planners and should not be used as a substitute for specific on-site investigations.

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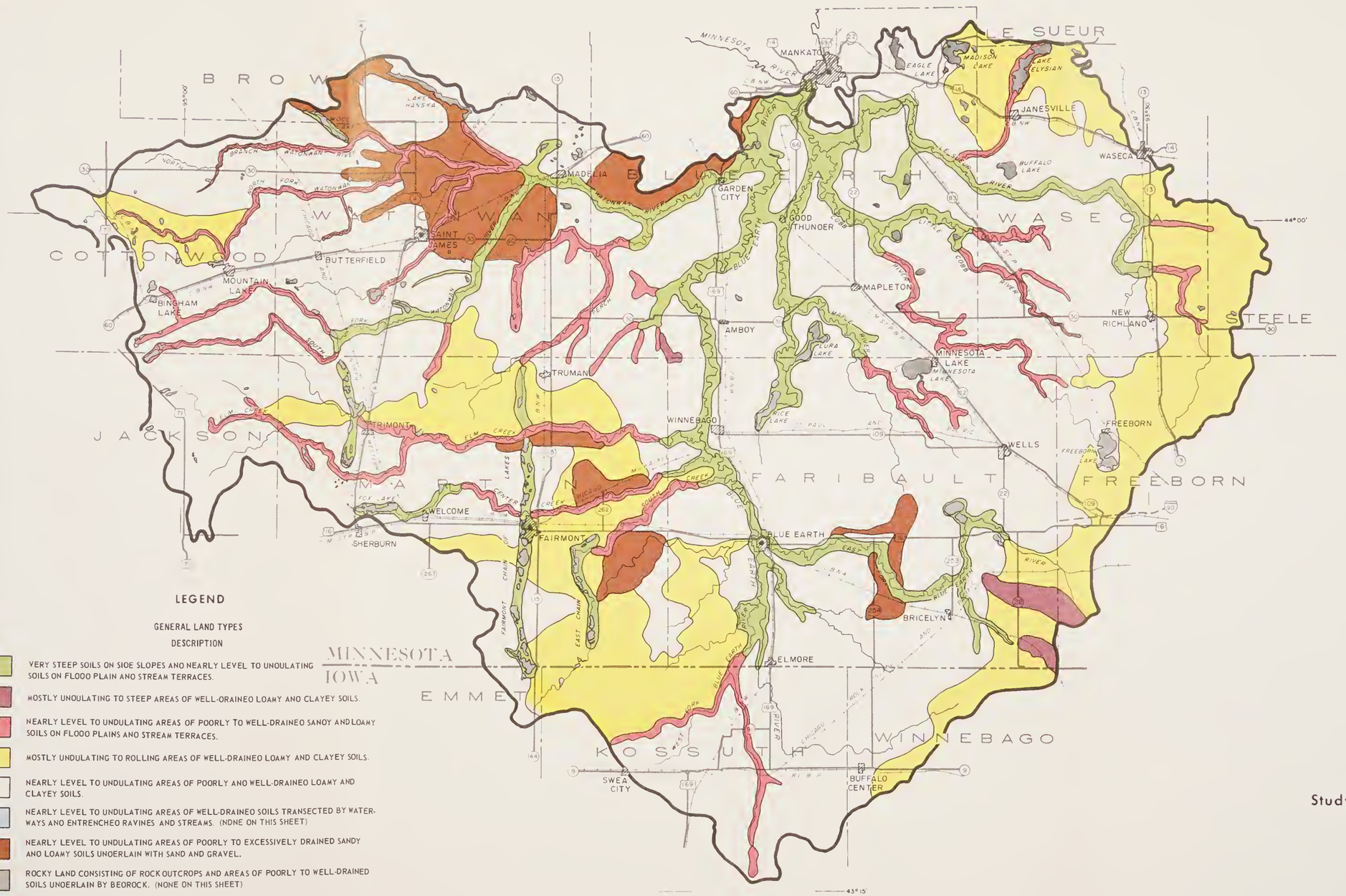


BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD

LEGEND

GENERAL LAND TYPES

CODE	DESCRIPTION
	VERY STEEP SOILS ON SIOE SLOPES ANO NEARLY LEVEL TO UNOULATING SOILS ON FLOOO PLAIN ANO STREAM TERRACES.
	MOSTLY UNOULATING TO STEEP AREAS OF WELL-ORAINEO LOAMY ANO CLAYEY SOILS.
	NEARLY LEVEL TO UNDULATING AREAS OF POORLY TO WELL-DRAINEO SANOY AND LOAMY SOILS ON FLOOO PLAINS ANO STREAM TERRACES.
	MOSTLY UNDULATING TO ROLLING AREAS OF WELL-DRAINEO LOAMY AND CLAYEY SOILS.
	NEARLY LEVEL TO UNDULATING AREAS OF POORLY ANO WELL-DRAINEO LOAMY AND CLAYEY SOILS.
	NEARLY LEVEL TO UNDULATING AREAS OF WELL-DRAINEO SOILS TRANSECTED BY WATER-WAYS ANO ENTRENCHEO RAVINES AND STREAMS. (NONE ON THIS SHEET)
	NEARLY LEVEL TO UNDULATING AREAS OF POORLY TO EXCESSIVELY DRAINED SANDY ANO LOAMY SOILS UNOERLAIN WITH SAND AND GRAVEL.
	ROCKY LAND CONSISTING OF ROCK OUTCROPS AND AREAS OF POORLY TO WELL-DRAINED SOILS UNOERLAIN BY BEOROCK. (NONE ON THIS SHEET)
	MOSTLY UNDULATING TO STEEP AREAS OF WELL TO EXCESSIVELY ORAINEO SOILS UNDER-LAIN WITH SANO AND GRAVEL. (NONE ON THIS SHEET)

SCALE 1/500,000

SCALE 5 0 5 10 15 MILES

SOURCE
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-24,226 AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION

USDA SCS LINCOLN NEBR 1975

GENERAL LAND TYPES

Study Area 1 - BLUE EARTH RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

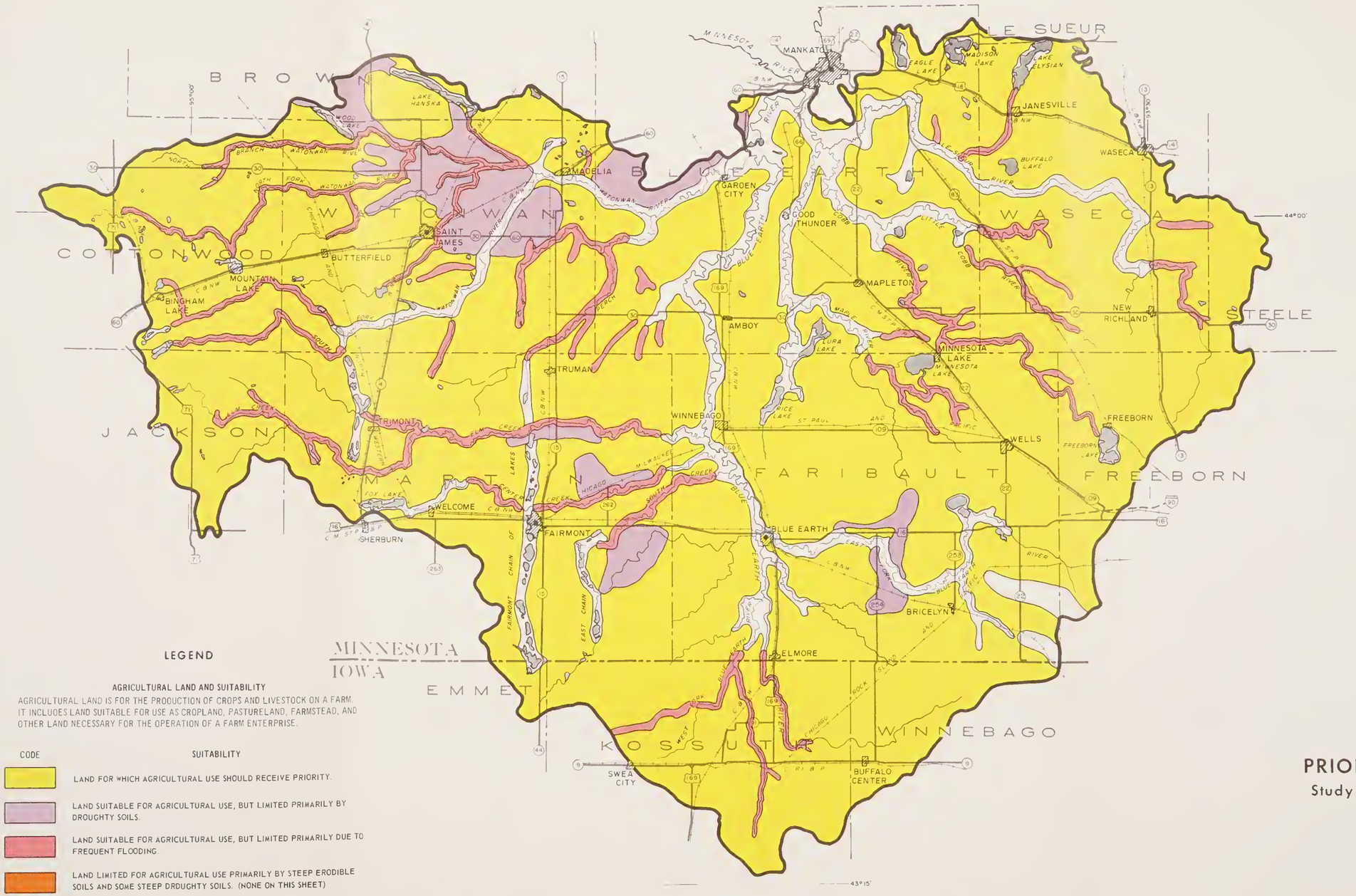
SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 1

REV 9-75
5,S-30592

U. S. DEPARTMENT OF AGRICULTURE



BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD

LEGEND

AGRICULTURAL LAND AND SUITABILITY

AGRICULTURAL LAND IS FOR THE PRODUCTION OF CROPS AND LIVESTOCK ON A FARM. IT INCLUDES LAND SUITABLE FOR USE AS CROPLAND, PASTURELAND, FARMSTEAD, AND OTHER LAND NECESSARY FOR THE OPERATION OF A FARM ENTERPRISE.

CODE	SUITABILITY
	LAND FOR WHICH AGRICULTURAL USE SHOULD RECEIVE PRIORITY.
	LAND SUITABLE FOR AGRICULTURAL USE, BUT LIMITED PRIMARILY BY DROUGHTY SOILS.
	LAND SUITABLE FOR AGRICULTURAL USE, BUT LIMITED PRIMARILY DUE TO FREQUENT FLOODING.
	LAND LIMITED FOR AGRICULTURAL USE PRIMARILY BY STEEP ERODIBLE SOILS AND SOME STEEP DROUGHTY SOILS. (NONE ON THIS SHEET)
	LAND FOR WHICH OTHER USES SHOULD RECEIVE PRIORITY.

SCALE 1/500,000

SCALE 5 0 5 10 15 MILES

PRIORITY LAND USE - AGRICULTURE

Study Area I - BLUE EARTH RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

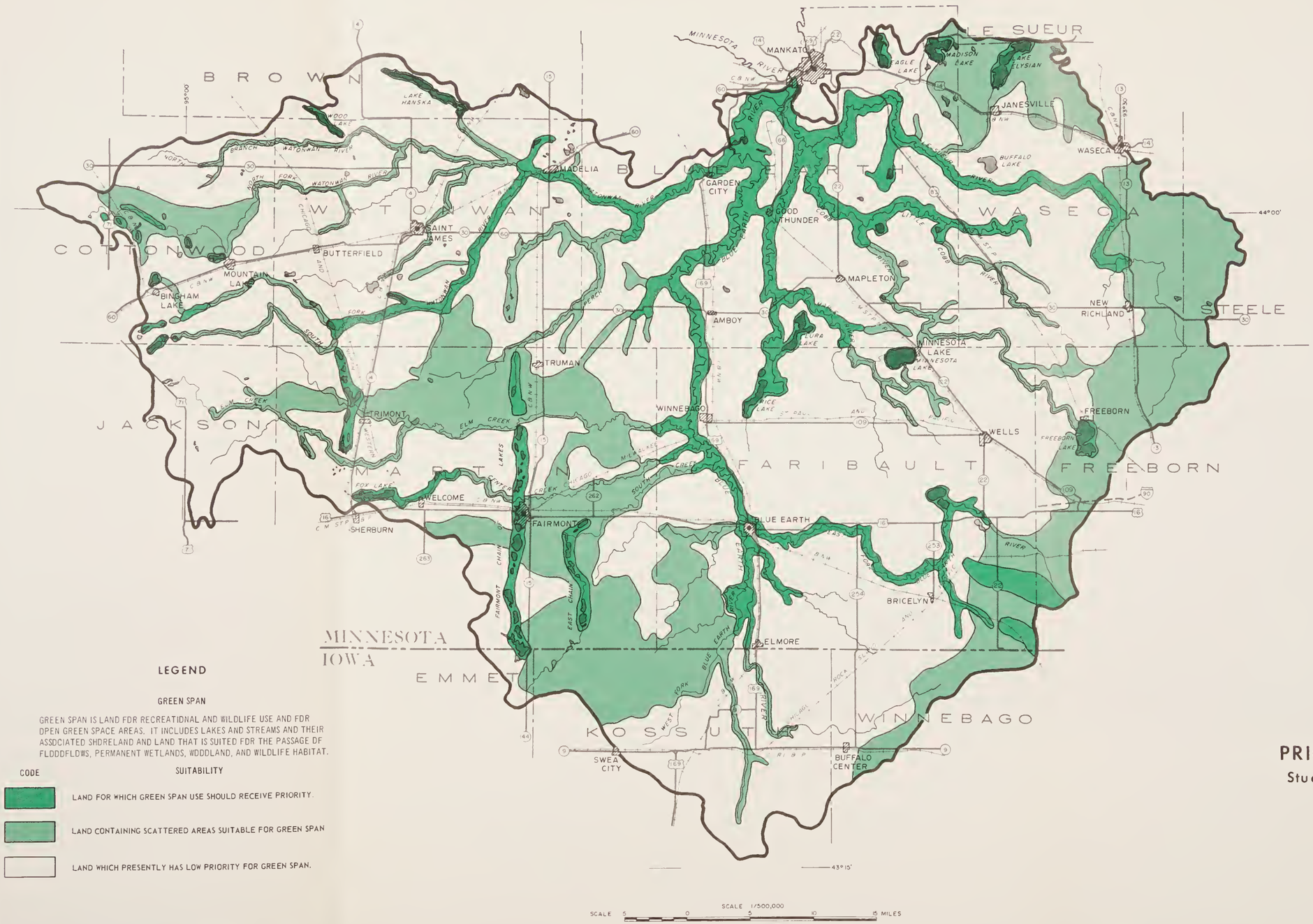
FIGURE 2

SOURCE
FAMILY OF MAPS - SCS DRAWING NUMBER S.S. 29,226 AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION

USDA SCS LINCOLN, NEBR. 1975

REV. 10-75
S.S-30593

U. S. DEPARTMENT OF AGRICULTURE



MINNESOTA

N

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD

LEGEND

GREEN SPAN

GREEN SPAN IS LAND FOR RECREATIONAL AND WILDLIFE USE AND FOR OPEN GREEN SPACE AREAS. IT INCLUDES LAKES AND STREAMS AND THEIR ASSOCIATED SHORELAND AND LAND THAT IS SUITED FOR THE PASSAGE OF FLOODFLOWS, PERMANENT WETLANDS, WOODLAND, AND WILDLIFE HABITAT.

CODE	SUITABILITY
	LAND FOR WHICH GREEN SPAN USE SHOULD RECEIVE PRIORITY.
	LAND CONTAINING SCATTERED AREAS SUITABLE FOR GREEN SPAN
	LAND WHICH PRESENTLY HAS LOW PRIORITY FOR GREEN SPAN.

SCALE 1/500,000

SCALE 5 0 5 10 15 MILES

PRIORITY LAND USE - GREEN SPAN

Study Area 1 - BLUE EARTH RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

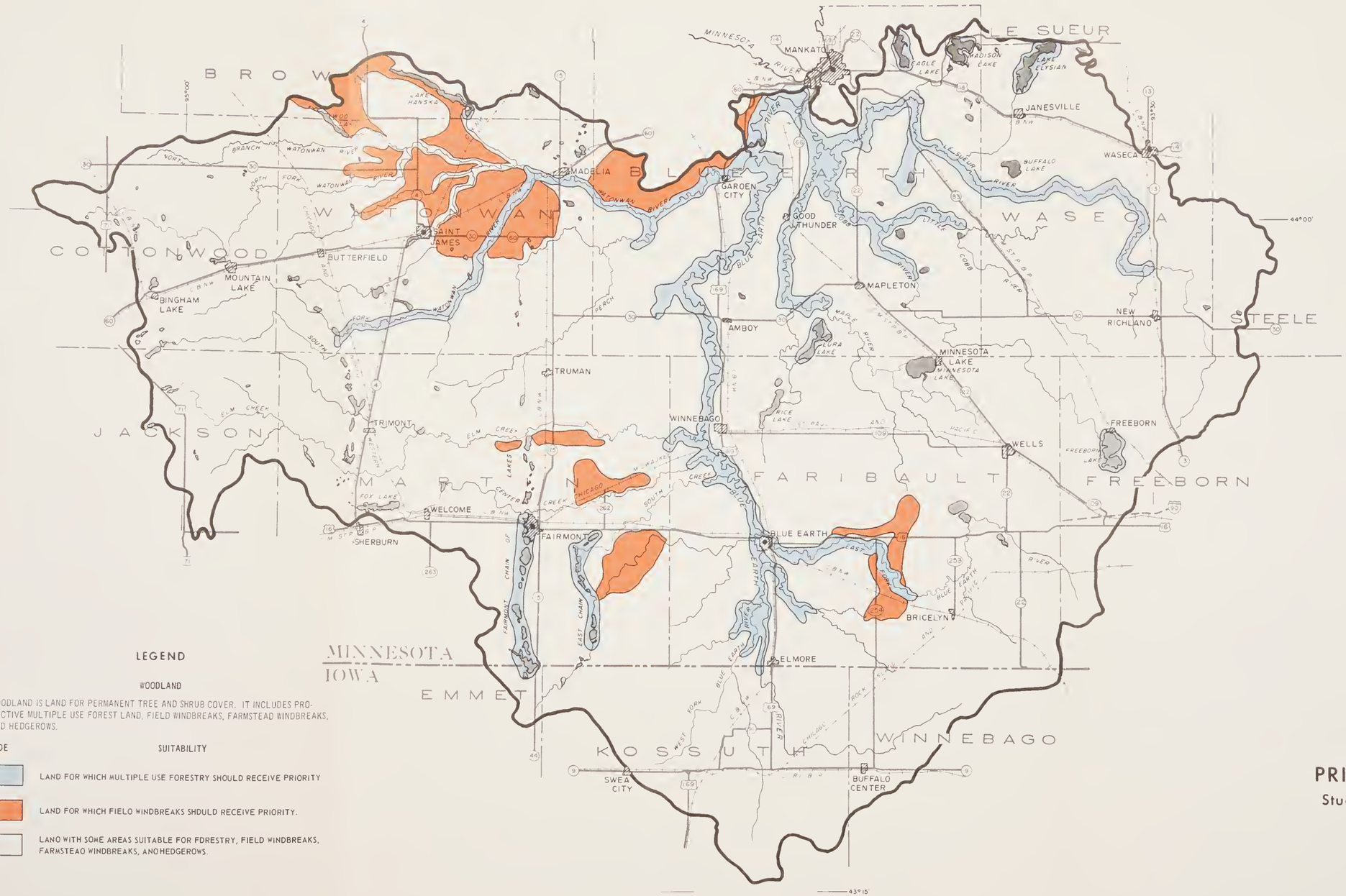
FIGURE 3

SOURCE
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-29,226 AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.

USDA-SCS LINCOLN NEBR 1975

REV. 10-75
5,S-30594

U. S. DEPARTMENT OF AGRICULTURE



MINNESOTA

N

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD

LEGEND

WOODLAND

WOODLAND IS LAND FOR PERMANENT TREE AND SHRUB COVER. IT INCLUDES PRODUCTIVE MULTIPLE USE FOREST LAND, FIELD WINDBREAKS, FARMSTEAD WINDBREAKS, AND HEDGEROWS.

CODE	SUITABILITY
	LAND FOR WHICH MULTIPLE USE FORESTRY SHOULD RECEIVE PRIORITY
	LAND FOR WHICH FIELD WINDBREAKS SHOULD RECEIVE PRIORITY.
	LAND WITH SOME AREAS SUITABLE FOR FORESTRY, FIELD WINDBREAKS, FARMSTEAD WINDBREAKS, AND HEDGEROWS.

SCALE 1/500,000

SCALE 5 0 5 10 15 MILES

PRIORITY LAND USE - WOODLAND

Study Area 1 - BLUE EARTH RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

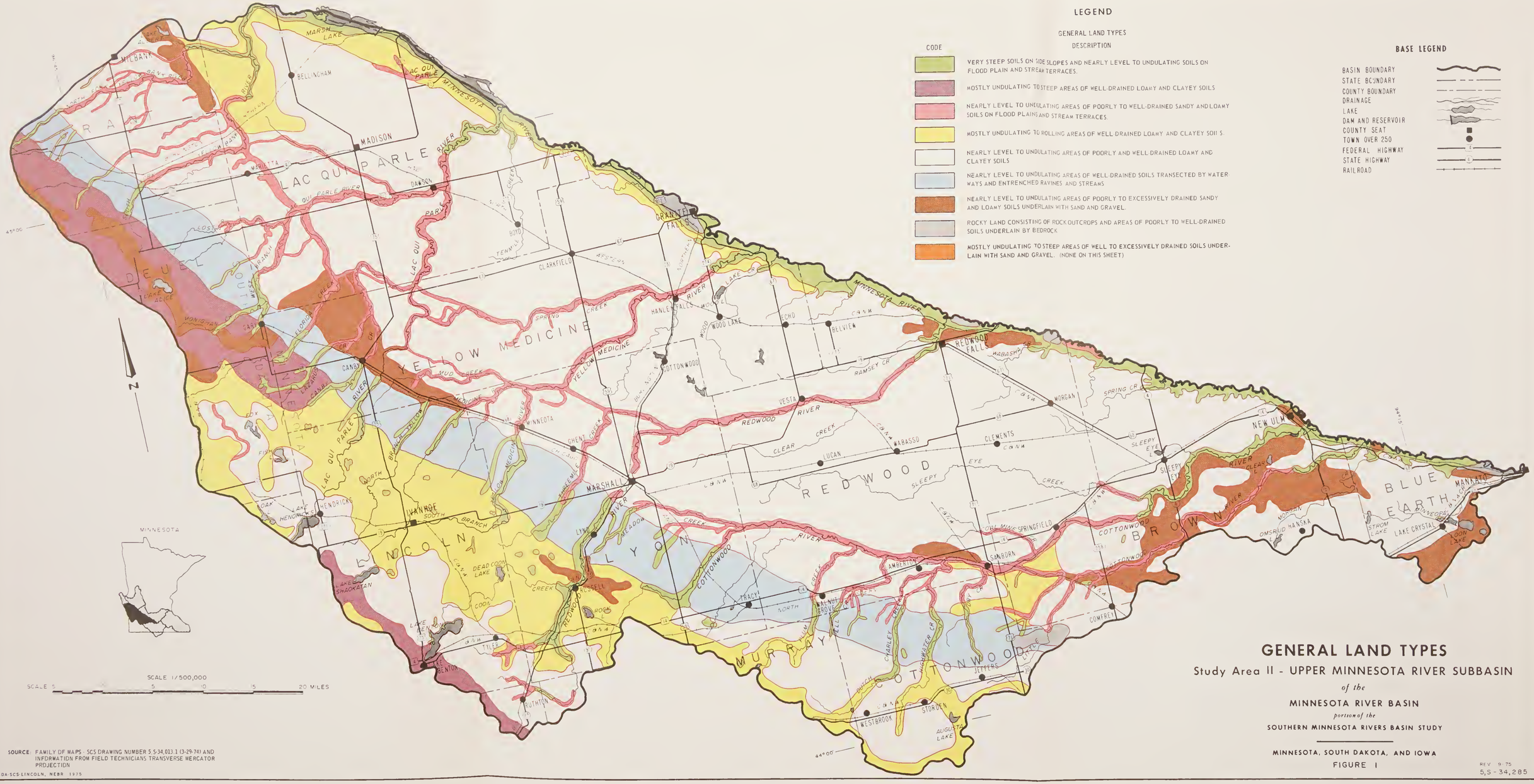
MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 4

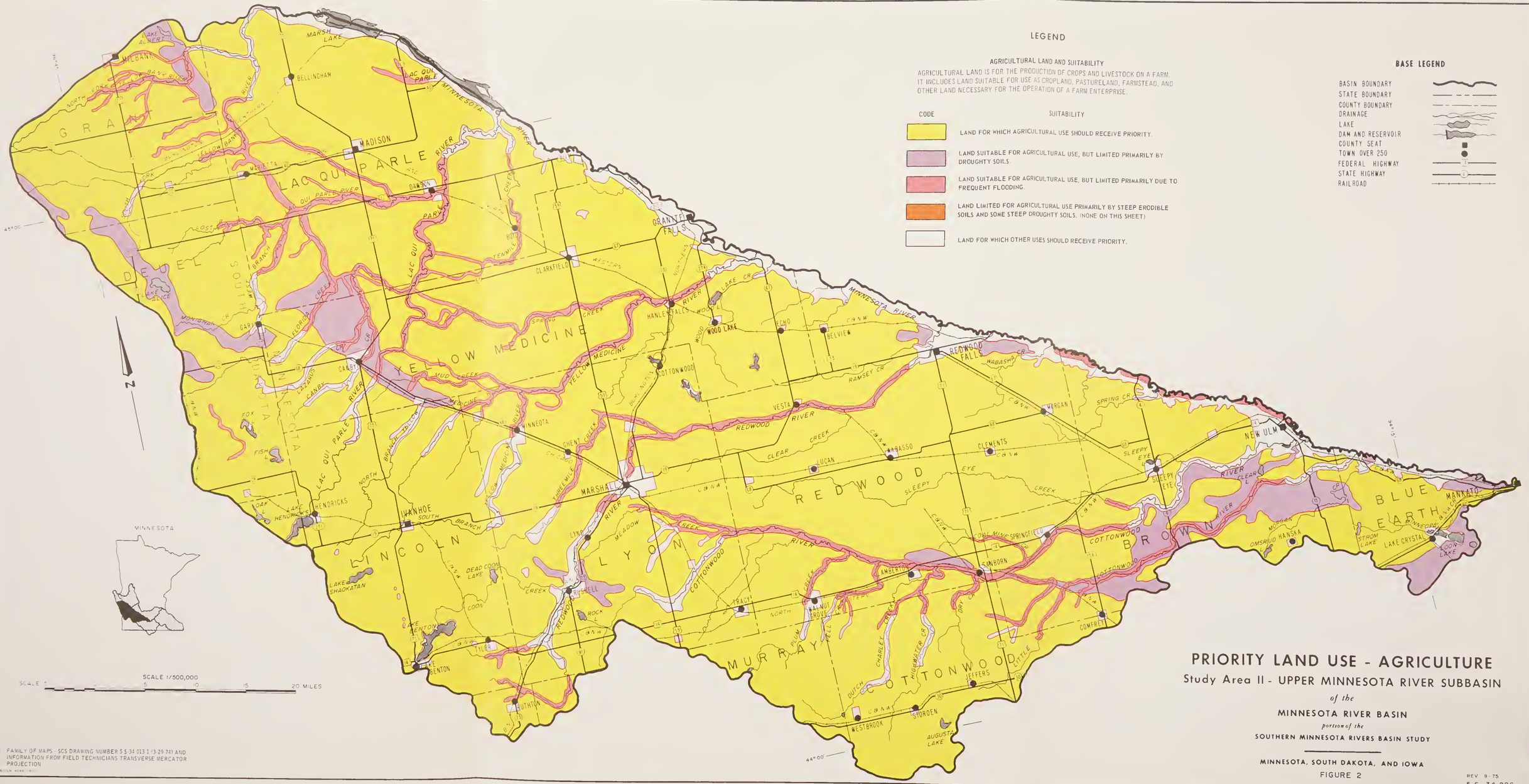
SOURCE
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-29,226 AND INFORMATION FROM FIELD TECHNICIANS TRANSVERSE MERCATOR PROJECTION
USDA SCS LINCOLN NEBR 1975

REV 10-75
5,S-30595

U. S DEPARTMENT OF AGRICULTURE



U. S. DEPARTMENT OF AGRICULTURE



PRIORITY LAND USE - AGRICULTURE

Study Area II - UPPER MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

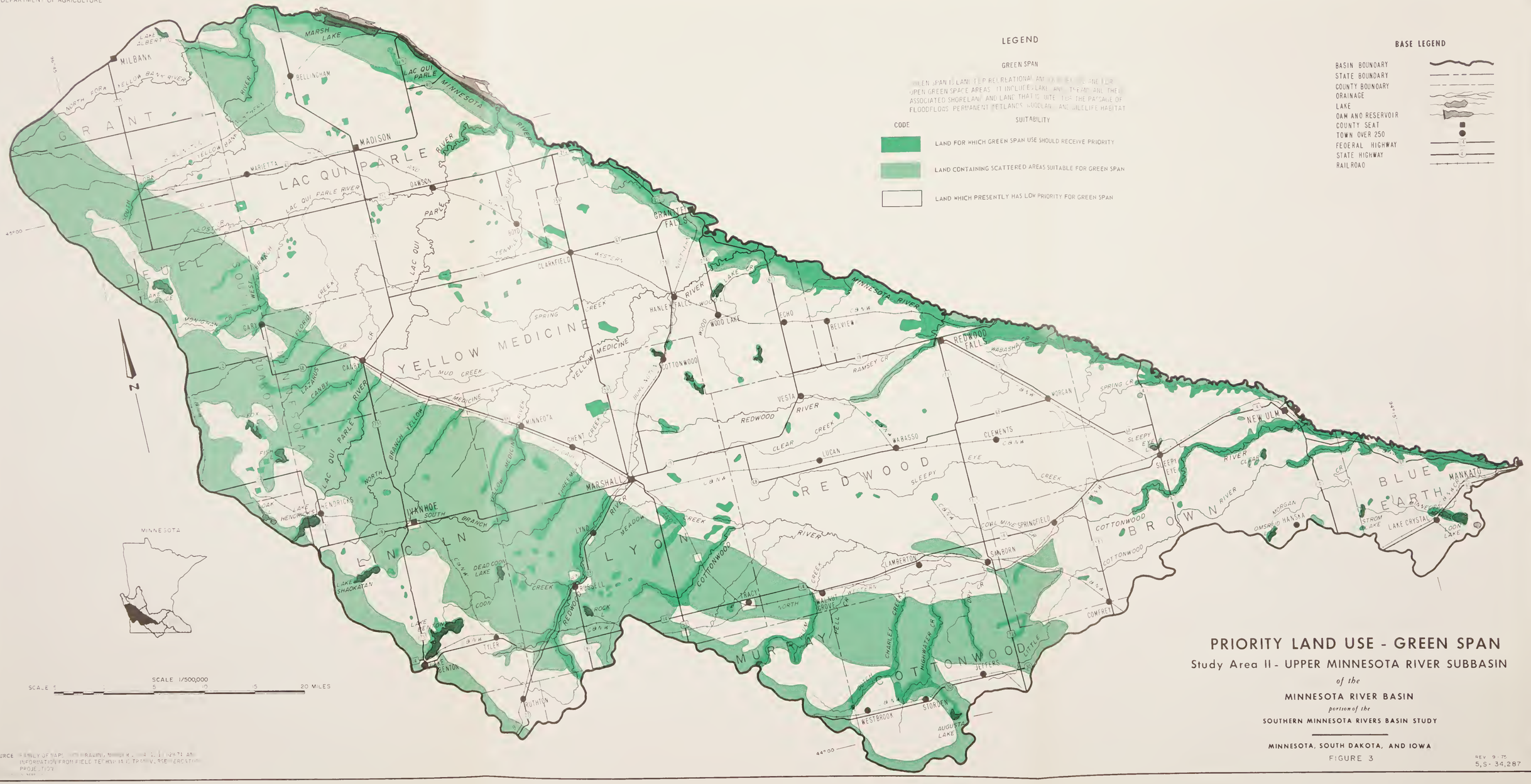
MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 2

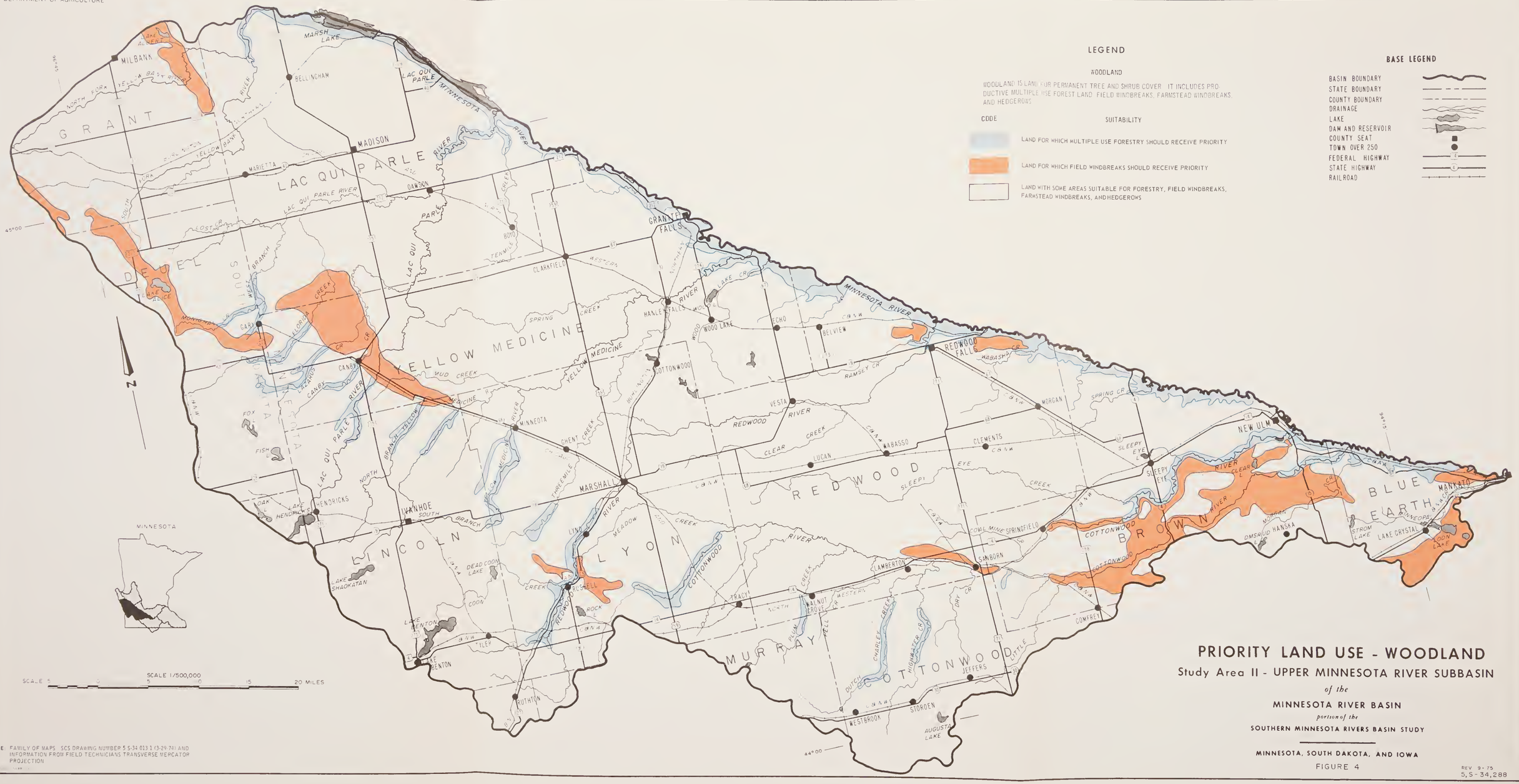
REV. 9-75

5,S-34,286

U. S. DEPARTMENT OF AGRICULTURE



U. S. DEPARTMENT OF AGRICULTURE



SOURCE: FAMILY OF MAPS, SCS DRAWING NUMBER 5 S-34 013 1 (3-29-74) AND INFORMATION FROM FIELD TECHNICIANS TRANSVERSE MERCATOR PROJECTION

PRIORITY LAND USE - WOODLAND

Study Area II - UPPER MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

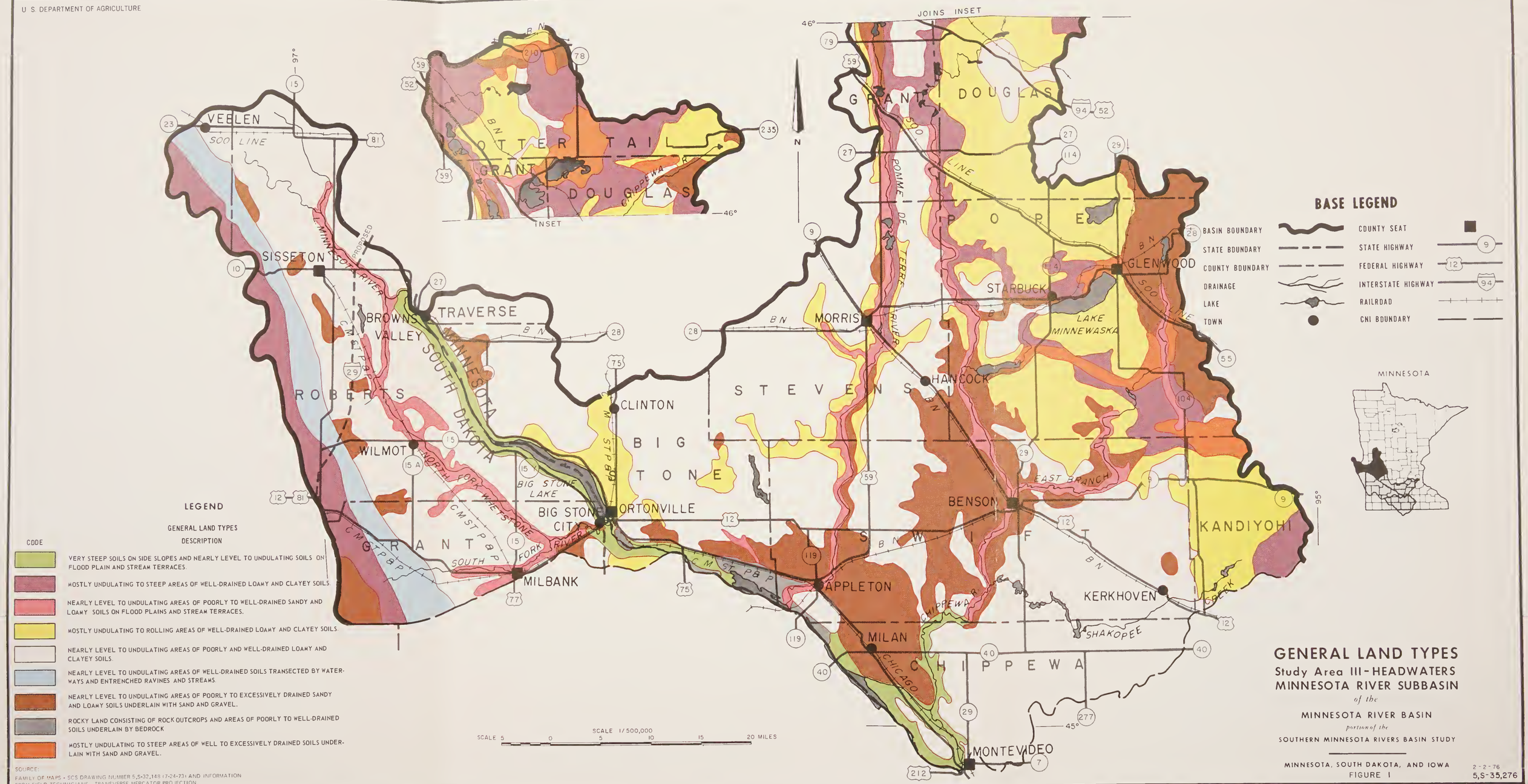
SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 4

REV. 9-75
5,S-34,288

U. S. DEPARTMENT OF AGRICULTURE



BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD
- CNI BOUNDARY

MINNESOTA

LEGEND

GENERAL LAND TYPES

CODE	DESCRIPTION
	VERY STEEP SOILS ON SIDE SLOPES AND NEARLY LEVEL TO UNDULATING SOILS ON FLOOD PLAIN AND STREAM TERRACES.
	MOSTLY UNDULATING TO STEEP AREAS OF WELL-DRAINED LOAMY AND CLAYEY SOILS.
	NEARLY LEVEL TO UNDULATING AREAS OF POORLY TO WELL-DRAINED SANDY AND LOAMY SOILS ON FLOOD PLAINS AND STREAM TERRACES.
	MOSTLY UNDULATING TO ROLLING AREAS OF WELL-DRAINED LOAMY AND CLAYEY SOILS.
	NEARLY LEVEL TO UNDULATING AREAS OF POORLY AND WELL-DRAINED LOAMY AND CLAYEY SOILS.
	NEARLY LEVEL TO UNDULATING AREAS OF WELL-DRAINED SOILS TRANSECTED BY WATERWAYS AND ENTRENCHED RAVINES AND STREAMS.
	NEARLY LEVEL TO UNDULATING AREAS OF POORLY TO EXCESSIVELY DRAINED SANDY AND LOAMY SOILS UNDERLAIN WITH SAND AND GRAVEL.
	ROCKY LAND CONSISTING OF ROCK OUTCROPS AND AREAS OF POORLY TO WELL-DRAINED SOILS UNDERLAIN BY BEDROCK
	MOSTLY UNDULATING TO STEEP AREAS OF WELL TO EXCESSIVELY DRAINED SOILS UNDERLAIN WITH SAND AND GRAVEL.

SOURCE:
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-32,148 (7-24-73) AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.
USDA-SCS-LINCOLN, NEBR. 1976

GENERAL LAND TYPES

Study Area III - HEADWATERS MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

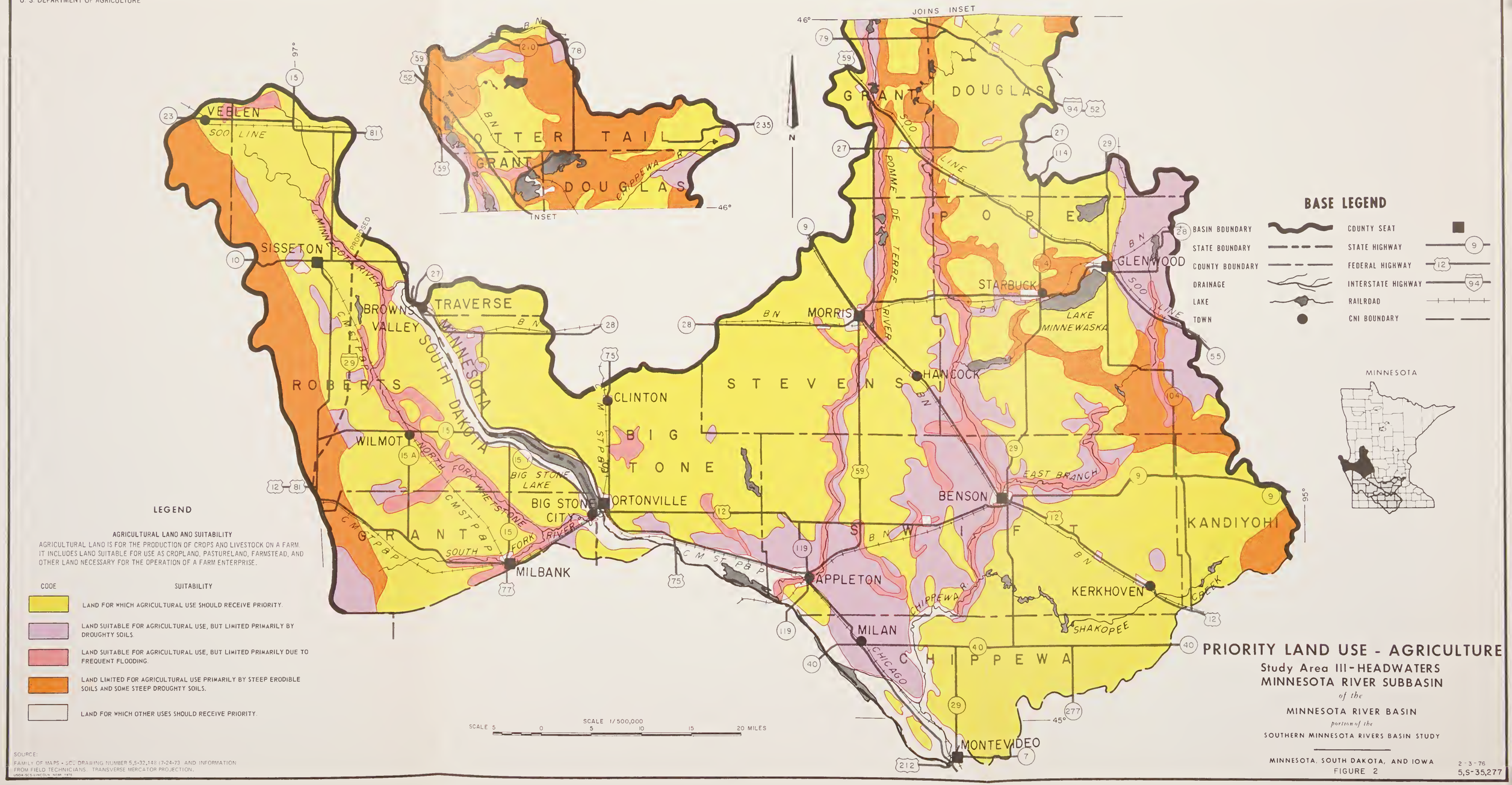
SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 1

2-2-76
5,S-35,276

U. S. DEPARTMENT OF AGRICULTURE



MINNESOTA

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD
- CNI BOUNDARY

LEGEND

AGRICULTURAL LAND AND SUITABILITY

AGRICULTURAL LAND IS FOR THE PRODUCTION OF CROPS AND LIVESTOCK ON A FARM. IT INCLUDES LAND SUITABLE FOR USE AS CROPLAND, PASTURELAND, FARMSTEAD, AND OTHER LAND NECESSARY FOR THE OPERATION OF A FARM ENTERPRISE.

CODE	SUITABILITY
	LAND FOR WHICH AGRICULTURAL USE SHOULD RECEIVE PRIORITY.
	LAND SUITABLE FOR AGRICULTURAL USE, BUT LIMITED PRIMARILY BY DROUGHTY SOILS.
	LAND SUITABLE FOR AGRICULTURAL USE, BUT LIMITED PRIMARILY DUE TO FREQUENT FLOODING.
	LAND LIMITED FOR AGRICULTURAL USE PRIMARILY BY STEEP ERODIBLE SOILS AND SOME STEEP DROUGHTY SOILS.
	LAND FOR WHICH OTHER USES SHOULD RECEIVE PRIORITY.

SCALE 1/500,000

SCALE 5 0 5 10 15 20 MILES

SOURCE:
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-32,148 (7-24-73 AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.
USDA-SCS-LINCOLN, NEB. 1976

PRIORITY LAND USE - AGRICULTURE

Study Area III - HEADWATERS MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

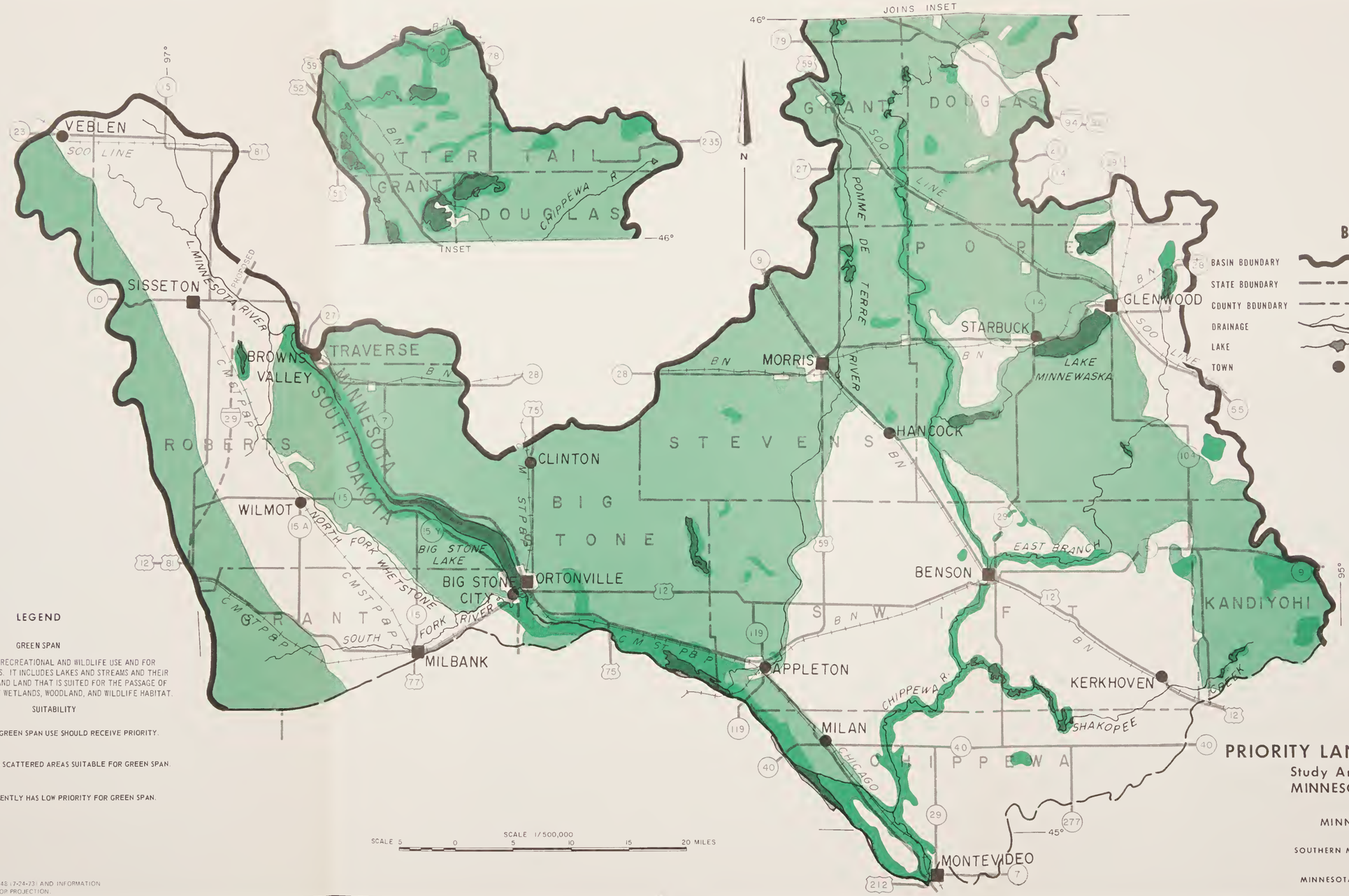
MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 2

2-3-76

5,S-35,277

U. S. DEPARTMENT OF AGRICULTURE



BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD
- CNI BOUNDARY

MINNESOTA

LEGEND

GREEN SPAN

GREEN SPAN IS LAND FOR RECREATIONAL AND WILDLIFE USE AND FOR OPEN GREEN SPACE AREAS. IT INCLUDES LAKES AND STREAMS AND THEIR ASSOCIATED SHORELAND AND LAND THAT IS SUITED FOR THE PASSAGE OF FLOODFLOWS, PERMANENT WETLANDS, WOODLAND, AND WILDLIFE HABITAT.

CODE	SUITABILITY
	LAND FOR WHICH GREEN SPAN USE SHOULD RECEIVE PRIORITY.
	LAND CONTAINING SCATTERED AREAS SUITABLE FOR GREEN SPAN.
	LAND WHICH PRESENTLY HAS LOW PRIORITY FOR GREEN SPAN.

PRIORITY LAND USE - GREEN SPAN

Study Area III - HEADWATERS MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 3

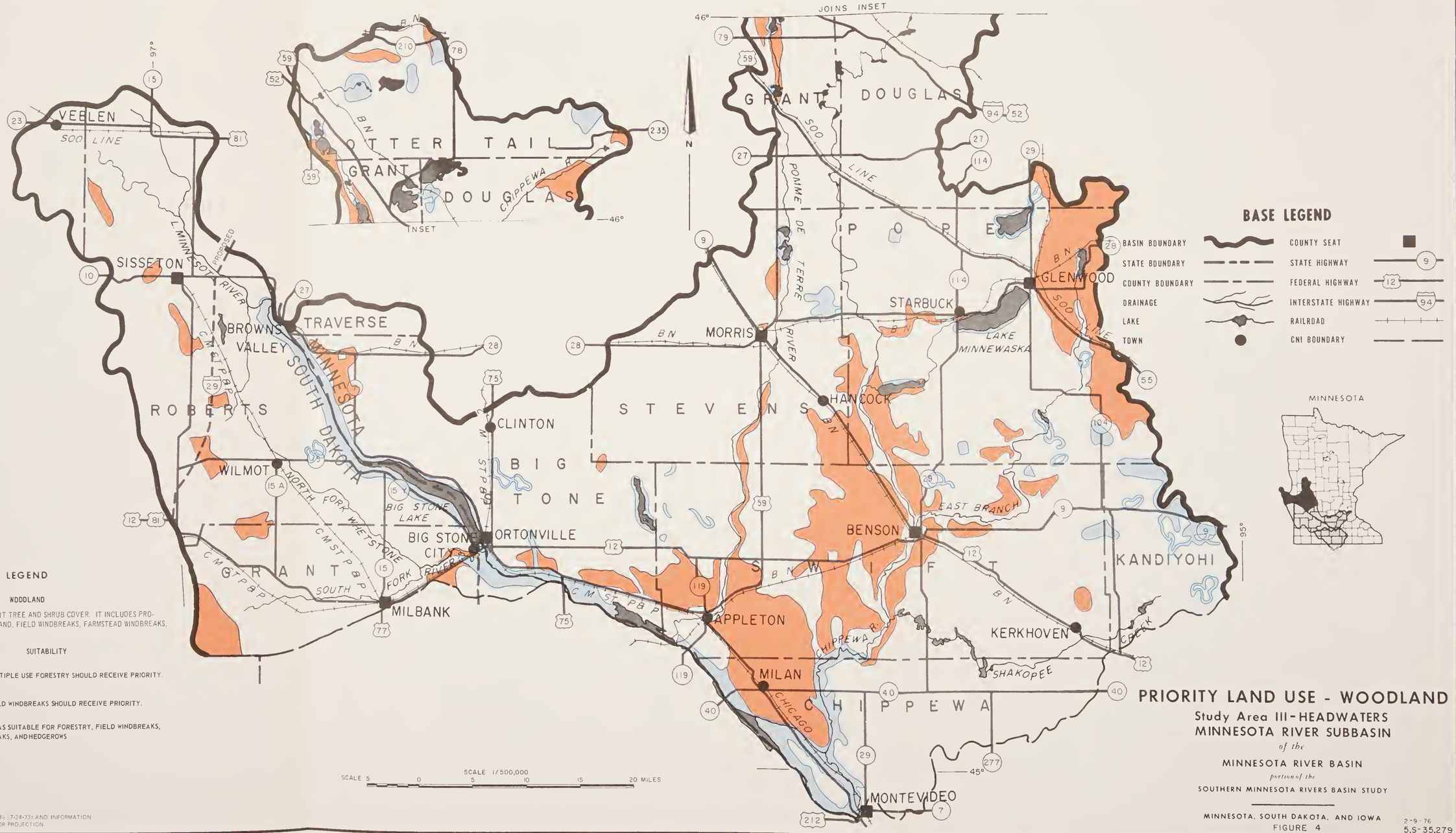
2-3-76

5,S-35,278

SOURCE:
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-32,148 (7-24-73) AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.

USDA-SCS-LINCOLN, NEB. 1976

U. S. DEPARTMENT OF AGRICULTURE



BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- TOWN
- COUNTY SEAT
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD
- CNI BOUNDARY

MINNESOTA

LEGEND

WOODLAND

WOODLAND IS LAND FOR PERMANENT TREE AND SHRUB COVER. IT INCLUDES PRODUCTIVE MULTIPLE USE FOREST LAND, FIELD WINDBREAKS, FARMSTEAD WINDBREAKS, AND HEDGEROWS.

CODE	SUITABILITY
	LAND FOR WHICH MULTIPLE USE FORESTRY SHOULD RECEIVE PRIORITY.
	LAND FOR WHICH FIELD WINDBREAKS SHOULD RECEIVE PRIORITY.
	LAND WITH SOME AREAS SUITABLE FOR FORESTRY, FIELD WINDBREAKS, FARMSTEAD WINDBREAKS, AND HEDGEROWS

PRIORITY LAND USE - WOODLAND

Study Area III - HEADWATERS MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

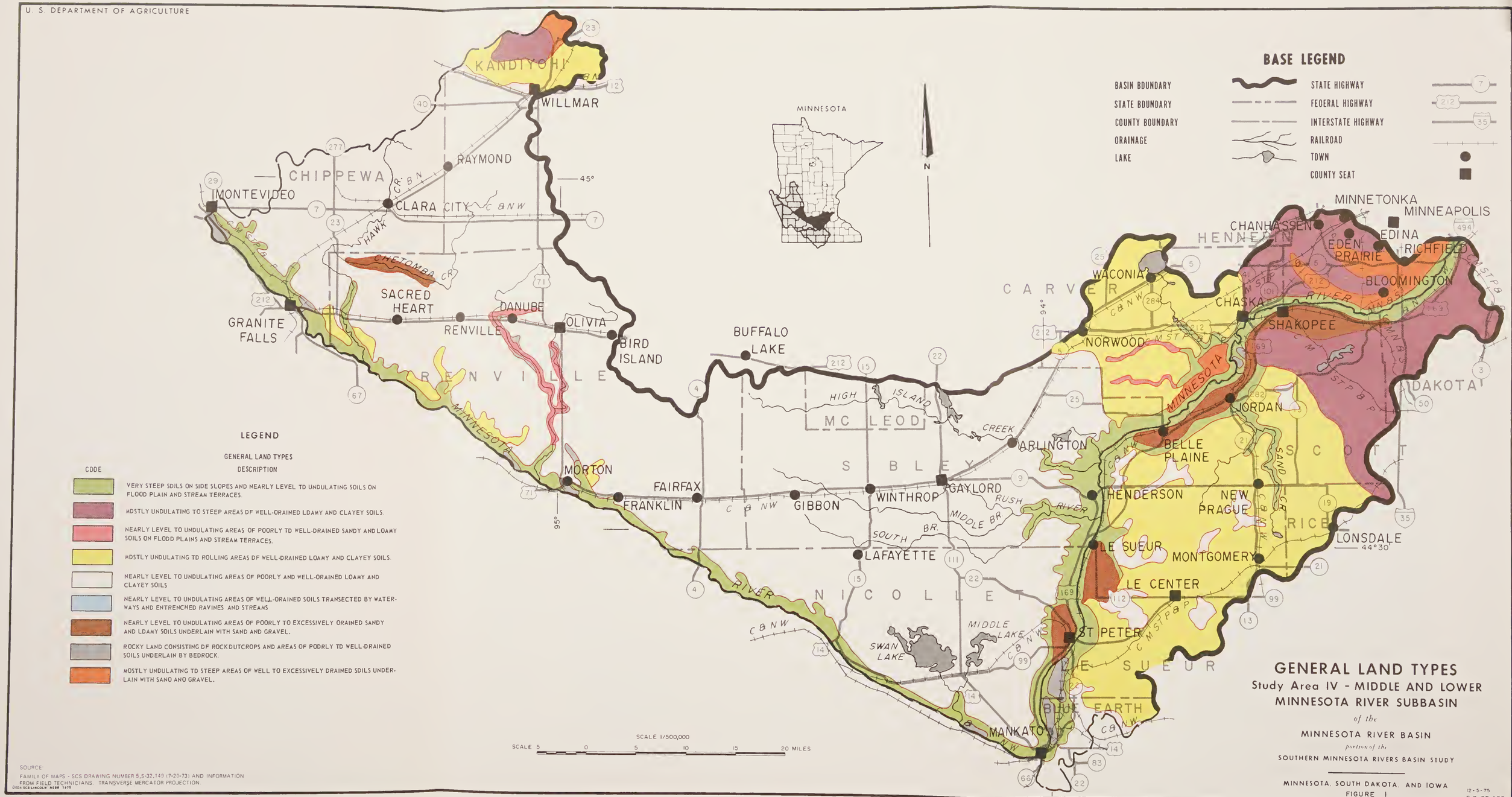
FIGURE 4

2-9-76

5,S-35,279

SOURCE:
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-32,148 7-24-73 AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.
USDA-SCS-LINCOLN, NEBR. 1976

U. S. DEPARTMENT OF AGRICULTURE



BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD
- TOWN
- COUNTY SEAT

LEGEND

GENERAL LAND TYPES

CODE	DESCRIPTION
	VERY STEEP SOILS ON SIDE SLOPES AND NEARLY LEVEL TO UNDULATING SOILS ON FLOOD PLAIN AND STREAM TERRACES.
	MOSTLY UNDULATING TO STEEP AREAS OF WELL-DRAINED LOAMY AND CLAYEY SOILS.
	NEARLY LEVEL TO UNDULATING AREAS OF POORLY TO WELL-DRAINED SANDY AND LOAMY SOILS ON FLOOD PLAINS AND STREAM TERRACES.
	MOSTLY UNDULATING TO ROLLING AREAS OF WELL-DRAINED LOAMY AND CLAYEY SOILS.
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	NEARLY LEVEL TO UNDULATING AREAS OF POORLY TO EXCESSIVELY DRAINED SANDY AND LOAMY SOILS UNDERLAIN WITH SAND AND GRAVEL.
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	MOSTLY UNDULATING TO STEEP AREAS OF WELL TO EXCESSIVELY DRAINED SOILS UNDERLAIN WITH SAND AND GRAVEL.

SOURCE:
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-32,149 (7-20-73) AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.
USDA-SCS-LINCOLN, NEBR. 1975

GENERAL LAND TYPES

Study Area IV - MIDDLE AND LOWER MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

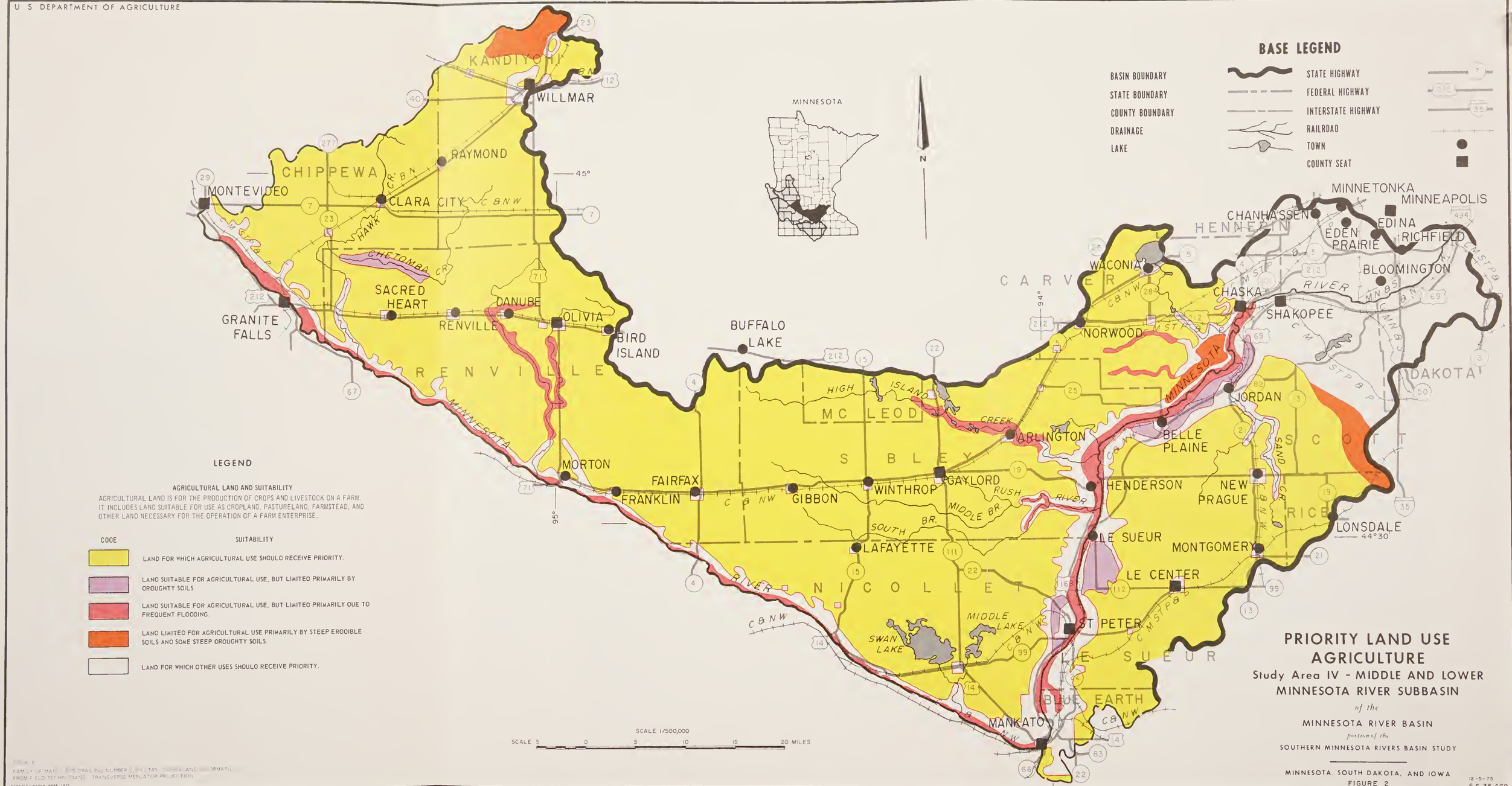
SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 1

12-5-75
5,S-35,468

U S DEPARTMENT OF AGRICULTURE



BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD
- TOWN
- COUNTY SEAT

LEGEND

AGRICULTURAL LAND AND SUITABILITY

AGRICULTURAL LAND IS FOR THE PRODUCTION OF CROPS AND LIVESTOCK ON A FARM. IT INCLUDES LAND SUITABLE FOR USE AS CROPLAND, PASTURELAND, FARMSTEAD, AND OTHER LAND NECESSARY FOR THE OPERATION OF A FARM ENTERPRISE.

CODE	SUITABILITY
	LAND FOR WHICH AGRICULTURAL USE SHOULD RECEIVE PRIORITY.
	LAND SUITABLE FOR AGRICULTURAL USE, BUT LIMITED PRIMARILY BY DROUGHTY SOILS
	LAND SUITABLE FOR AGRICULTURAL USE, BUT LIMITED PRIMARILY DUE TO FREQUENT FLOODING.
	LAND LIMITED FOR AGRICULTURAL USE PRIMARILY BY STEEP ERODIBLE SOILS AND SOME STEEP DROUGHTY SOILS.
	LAND FOR WHICH OTHER USES SHOULD RECEIVE PRIORITY.

SCALE 1/500,000

SCALE 5 0 5 10 15 20 MILES

PRIORITY LAND USE AGRICULTURE

Study Area IV - MIDDLE AND LOWER MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

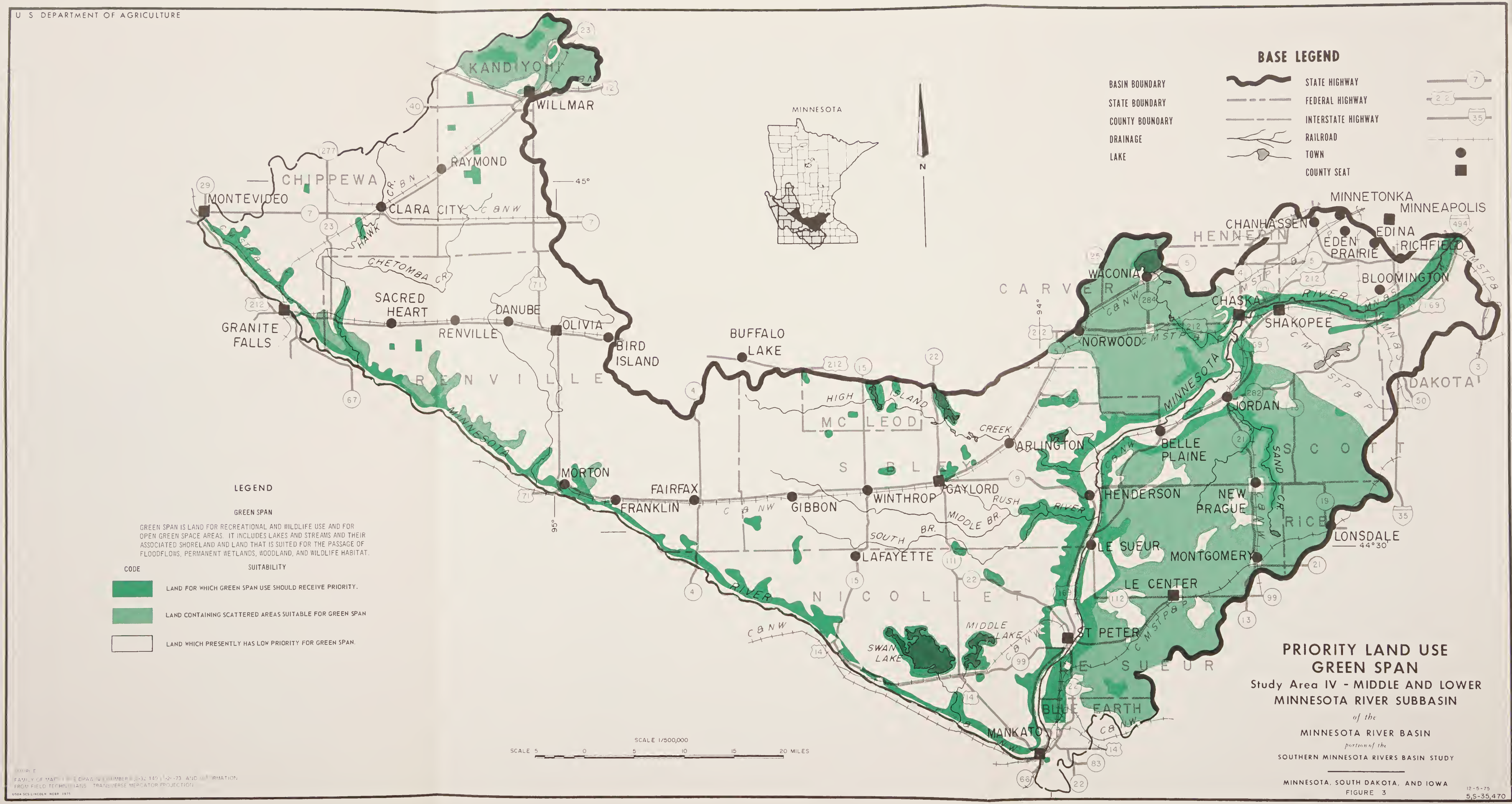
FIGURE 2

12-5-75

5,S-35,469

FAMILY USE MAPS - U.S. DEPARTMENT NUMBER [illegible] 149 SOILS AND [illegible] FROM FIELD TECHNICIANS TRANSVERSE MERCATOR PROJECTION

6104 SCS-LINCOLN, NEBR. 1975


U S DEPARTMENT OF AGRICULTURE
BASE LEGEND
BASIN BOUNDARY
STATE BOUNDARY
COUNTY BOUNDARY
DRAINAGE
LAKE
STATE HIGHWAY
FEDERAL HIGHWAY
INTERSTATE HIGHWAY
RAILROAD
TOWN
COUNTY SEAT
MINNESOTA
N
LEGEND
GREEN SPAN
GREEN SPAN IS LAND FOR RECREATIONAL AND WILDLIFE USE AND FOR OPEN GREEN SPACE AREAS. IT INCLUDES LAKES AND STREAMS AND THEIR ASSOCIATED SHORELAND AND LAND THAT IS SUITED FOR THE PASSAGE OF FLOODFLOWS, PERMANENT WETLANDS, WOODLAND, AND WILDLIFE HABITAT.
CODE
SUITABILITY
LAND FOR WHICH GREEN SPAN USE SHOULD RECEIVE PRIORITY.
LAND CONTAINING SCATTERED AREAS SUITABLE FOR GREEN SPAN
LAND WHICH PRESENTLY HAS LOW PRIORITY FOR GREEN SPAN.
KANDIYOHI
WILLMAR
CHIPPEWA
RAYMOND
MONTEVIDEO
CLARA CITY
CHETOMBA CR
HAWK CR
SACRED HEART
RENVILLE
DANUBE
OLIVIA
BIRD ISLAND
GRANITE FALLS
R E N V I L L E
MINNESOTA
MORTON
FAIRFAX
FRANKLIN
GIBBON
WINTHROP
GAYLORD
BUFFALO LAKE
HIGH ISLAND CREEK
MC LEOD
S I B L E Y
ARLINGTON
RUSH RIVER
MIDDLE BR.
SOUTH BR.
LAFAYETTE
N I C O L L E T
RIVER
SWAN LAKE
MIDDLE LAKE
ST PETER
MANKATO
BLUE EARTH
L E S U E U R
LE CENTER
LE SUEUR
MONTGOMERY
HENDERSON
NEW PRAGUE
BELLE PLAINE
JORDAN
S C O T T
SAND CR.
RICE
LONSDALE
DAKOTA
C A R V E R
WACONIA
NORWOOD
CHASKA
SHAKOPEE
HENNEPIN
CHANHASSEN
MINNETONKA
MINNEAPOLIS
EDEN PRAIRIE
EDINA
RICHFIELD
BLOOMINGTON
45°
44°30'
95°
94°
SCALE 1/500,000
SCALE 5 0 5 10 15 20 MILES
PRIORITY LAND USE
GREEN SPAN
Study Area IV - MIDDLE AND LOWER MINNESOTA RIVER SUBBASIN
of the
MINNESOTA RIVER BASIN
portion of the
SOUTHERN MINNESOTA RIVERS BASIN STUDY
MINNESOTA, SOUTH DAKOTA, AND IOWA
FIGURE 3
12-5-75
5,S-35,470
FROM FIELD TECHNICIANS TRANSVERSE MERCATOR PROJECTION
USDA SCS LINCOLN NEBR 1975

U. S. DEPARTMENT OF AGRICULTURE

BASE LEGEND

- BASIN BOUNDARY
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- STATE HIGHWAY
- FEDERAL HIGHWAY
- INTERSTATE HIGHWAY
- RAILROAD
- TOWN
- COUNTY SEAT

LEGEND

WOODLAND

WOODLAND IS LAND FOR PERMANENT TREE AND SHRUB COVER. IT INCLUDES PRODUCTIVE MULTIPLE USE FOREST LAND, FIELD WINDBREAKS, FARMSTEAD WINDBREAKS, AND HEDGEROWS.

CODE	SUITABILITY
	LAND FOR WHICH MULTIPLE USE FORESTRY SHOULD RECEIVE PRIORITY.
	LAND FOR WHICH FIELD WINDBREAKS SHOULD RECEIVE PRIORITY.
	LAND WITH SOME AREAS SUITABLE FOR FORESTRY, FIELD WINDBREAKS, FARMSTEAD WINDBREAKS, AND HEDGEROWS.

PRIORITY LAND USE WOODLAND

Study Area IV - MIDDLE AND LOWER MINNESOTA RIVER SUBBASIN

of the

MINNESOTA RIVER BASIN

portion of the

SOUTHERN MINNESOTA RIVERS BASIN STUDY

MINNESOTA, SOUTH DAKOTA, AND IOWA

FIGURE 4

12-5-75

5,S-35,471

SOURCE:
FAMILY OF MAPS - SCS DRAWING NUMBER 5,S-32,149 (7-20-73) AND INFORMATION FROM FIELD TECHNICIANS. TRANSVERSE MERCATOR PROJECTION.

USDA-SCS-LINCOLN, NEBR. 1975